

# RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

Vol. 73

NOVEMBER 1959

No. 5

## CONTENTS

- TREATMENT OF BRONCHOGENIC CANCER WITH CONVENTIONAL X-RAYS ACCORDING TO A SPECIFIC TIME-DOSE PATTERN.  
*Sidney Rubinfeld, M.D., and Gustave Kaplan, M.D.* 671
- PULMONARY RADIATION REACTION: A VITAL-CAPACITY AND TIME-DOSE STUDY.  
*James R. Gish, M.D., E. O. Coates, M.D., Lucille A. DuSault, A.B., and Howard P. Doub, M.D.* 679
- ACCELERATED PALLIATIVE RADIATION THERAPY OF BRONCHIAL CARCINOMA WITH 250-KV ROENTGEN RAYS.  
*W. L. DeGinder, M.D., and B. K. Lovell, M.D.* 684
- RADIATION DOSIMETRY WITH FLUORODS (MINIATURE GLASS ROD DOSIMETRY).  
*Morris Hodara, M.S., Milton Friedman, M.D., and Gerald J. Hine, Ph.D.* 693
- SEGMENTAL COLITIS.  
*Richard H. Marshak, M.D., Bernard S. Wolf, M.D., and Joan Eliasoph, M.D.* 707
- DISPLACEMENT OF FAT PADS IN DISEASE AND INJURY OF THE ELBOW. A NEW RADIOGRAPHIC SIGN.  
*R. C. Bledsoe, M.D., and J. L. Izenstark, M.D.* 717
- DIAGNOSIS OF ESOPHAGEAL VARICES BY A NEW RADIOLOGIC METHOD. A PRELIMINARY REPORT.  
*M. H. Nathan, M.D.* 725
- SOME USES OF CINEFLUOROGRAPHY IN UROLOGIC DIAGNOSTIC PROBLEMS.  
*William N. Hanafey, M.D., and Roderick D. Turner, M.D.* 733
- SOME BASIC PRINCIPLES IN THE DIAGNOSIS OF CHEST DISEASES.  
*Benjamin Felson, M.D., Moderator; Felix G. Fleischner, M.D., John R. McDonald, M.D., and Coleman B. Rabin, M.D., Panelists* 740
- KILOVOLTAGE AND RADIOGRAPHIC EFFECT. INVESTIGATION LEADING TO A STANDARD X-RAY VALUE SCALE (X.V.S.) SYSTEM OF SIMPLIFIED EXPOSURES FOR CONVENTIONAL AND AUTOMATIC RADIOGRAPHY.  
*Gerhart S. Schwarz, M.D.* 749
- A LOCALIZATION SCHEME FOR RADIATION THERAPY PLANNING WITH THE THERATRON.  
*H. B. Latourette, M.D., C. S. Simons, Ph.D., and I. Lampe, M.D.* 762
- FATAL VENOUS INTRAVASATION OF BARIUM DURING A BARIUM ENEMA.  
*Lee S. Rosenberg, M.D., and Archie Fine, M.D.* 771
- IMPROVEMENT OF DIAGNOSTIC VALUE OF PHOTOFUOROGRAPHIC FILMS BY ELECTRONIC MEANS. A PRELIMINARY REPORT.  
*Myron Forman, M.D., Anthony Boreadis Borden, M.D., and J. Gershon-Cohen, M.D.* 774
- CERVICODORSAL DIVERTICULA OF THE SUBARACHNOID SPACE.  
*Robert Shapiro, M.D., and Franklin Robinson, M.D.* 776
- PROGRESSIVE PATIENT CARE IN RADIOLOGY.  
*John D. Reeves, M.D.* 779
- WORK IN PROGRESS. STUDIES IN CORONARY ARTERIOGRAPHY. SYSTOLIC VS. DIASTOLIC APPEARANCE OF THE CORONARY ARTERIES.  
*Otto Heinrich Hase, M.D., Duncan A. Holaday, M.D., and Ralph A. Deterling, Jr., M.D., Ph.D.* 785
- EDITORIAL. THE NINTH INTERNATIONAL CONGRESS OF RADIOLOGY. 787
- ANNOUNCEMENTS AND BOOK REVIEWS. 789
- ABSTRACTS OF CURRENT LITERATURE. 795

# RADIOLOGY

A MONTHLY PUBLICATION DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

PUBLISHED BY THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

## EDITOR

HOWARD P. DOUB, M.D.

Henry Ford Hospital, Detroit 2, Mich.

## ASSOCIATE EDITORS

Leo G. Rigler, M.D.  
Laurence L. Robbins, M.D.  
Harold W. Jacox, M.D.  
William R. Eyler, M.D.

## PUBLICATION COMMITTEE

William T. Moss, M.D., Chairman  
John A. Evans, M.D.  
John D. Reeves, M.D.

## EDITORIAL ASSISTANTS

Marion B. Crowell, A.B.  
Florence Roper Jeffery, A.B.  
Arlene W. Hipple, A.B.

## ADVISORY EDITORIAL BOARD

Richard H. Chamberlain, M.D.  
Edith H. Quimby, Sc.D.  
Arthur Purdy Stout, M.D.  
Donald S. Childs, Jr., M.D.

## GENERAL INFORMATION

Second-class mail privileges authorized at Syracuse, New York with additional entry at Easton, Pennsylvania. Acceptance for mailing at a special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized November 24, 1934. RADIOLOGY is published by the Radiological Society of North America as its official Journal. Publication office, 20th and Northampton Streets, Easton, Pa. Subscription rate \$10.00 per annum. Canadian postage, \$1.00 additional. Foreign postage, \$2.00 additional. Single copies \$2.00 each. All correspondence relative to business matters connected with the Radiological Society of North America and RADIOLOGY, or remittance for non-member subscriptions, should be made payable to the Radiological Society of North America and should be addressed to the BUSINESS MANAGER, DONALD S. CHILDS, M.D., 713 E. GENESEE STREET, SYRACUSE 2, NEW YORK. In requesting change of address, both the old and the new address should be given.

Dues to the Radiological Society of North America include subscription to RADIOLOGY and should be paid to DONALD S. CHILDS, M.D., SECRETARY-TREASURER, 713 E. GENESEE STREET, SYRACUSE 2, NEW YORK.

The rate for "want" advertisements for insertion in the Classified Section is 8 cents per word, minimum charge \$2.00. Remittance should accompany order. Rates for display advertisements will be furnished upon request.

Inquiries regarding the program for the Annual Meeting of the Society for the current year should be sent to the President.

RADIOLOGY is published under the supervision of the Publication Committee of the Radiological Society of North America, which reserves the right to reject any material submitted for publication, including advertisements. No responsibility is accepted by the Committee or the Editor for the opinions expressed by the

contributors, but the right is reserved to introduce such changes as may be necessary to make the contributions conform to the editorial standards of RADIOLOGY. Correspondence relating to publication of papers should be addressed to the EDITOR, HOWARD P. DOUB, M.D., HENRY FORD HOSPITAL, DETROIT 2, MICHIGAN.

Original articles will be accepted only with the understanding that they are contributed solely to RADIOLOGY. Articles in foreign languages will be translated if they are acceptable. Manuscripts should be typewritten double-spaced, with wide margins, on good paper, and the original, not a carbon copy, should be submitted. The author's full address should appear on the manuscript. It is advisable that a copy be retained for reference as manuscripts will not be returned.

Illustrations and tables should be kept within reasonable bounds, as the number which can be published without cost to the author is strictly limited. For excess figures and for illustrations in color, estimates will be furnished by the Editor. Photographic prints should be clear and distinct and on glossy paper. Drawings and charts should be in India ink on white or on blue-lined coordinate paper. Blueprints will not reproduce satisfactorily. All photographs and drawings should be numbered, the top should be indicated, and each should be accompanied by a legend with a corresponding number. Authors are requested to indicate on prints made from photomicrographs the different types of cells to which attention is directed, by drawing lines in India ink and writing in the margin. The lines will be reproduced, and the words will be set in type. Attention should be called to points which should be brought out in completed illustrations, by tracings and suitable texts. These instructions should be concise and clear.

As a convenience to contributors to RADIOLOGY who are unable to supply prints for their manuscripts, the Editor can arrange for intermediate prints from roentgenograms.

Contents of RADIOLOGY copyrighted 1959 by The Radiological Society of North America, Inc.



# RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES  
PUBLISHED BY THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

Vol. 73

NOVEMBER 1959

No. 5

## Treatment of Bronchogenic Cancer with Conventional X-Rays According to a Specific Time-Dose Pattern<sup>1</sup>

SIDNEY RUBENFELD, M.D.,<sup>2</sup> and GUSTAVE KAPLAN, M.D.<sup>3</sup>

THIS IS A report of 43 patients with advanced nonresectable cancer of the lung who received conventional x-ray therapy according to an abbreviated time-dose pattern and showed subjective and objective improvement.

Inoperable carcinoma of the lung is essentially an incurable disease either because of its local extension to vital structures (1) or because of distant metastasis. Experience has shown that when a dose of radiation sufficient to eradicate the local disease is delivered, irreparable changes in the surrounding normal lung tissue may be produced. While the morbidity secondary to these changes is incapacitating, it would be a small price to pay were the disease cured. However, with the frequent incidence of local extension and/or distant spread, both of which mitigate against cure, one should be circumspect in delivering high dosage to the lung.

There is little doubt that irradiation can induce a significant degree of palliation in a great many patients. This should be accomplished with a dose that will not inflict irreparable damage to the normal surrounding structures or debili-

tate the patient. The extreme debilitation which often necessitates interruption of the therapeutic cycle has been noted by many who employ curative or radical radiation therapy in lung cancer. A compromise in treatment policy has been ably expressed by Garland and Sisson (2): "If the disease is limited in extent and at all radiosensitive, moderate dosage will achieve as much as heavy dosage in the majority of cases; if it is neither limited nor sensitive, no tolerable radical dosage will be of significant benefit."

### MATERIAL AND METHODS

Forty-three consecutive patients with histologically proved cancer of the lung were treated with a uniform pattern. Treatments were given with x-rays generated at 250 kv, Thoraeus II (0.4 Sn) filter, h.v.l. 2.5 mm. Cu at 50 cm. distance, the output being 37 r/minute (air). The size of the field varied from 10 × 10 to 10 × 15 cm. All lesions received a calculated tumor dose of 3,000 r in fourteen elapsed days. Skin doses ranged approximately from 4,000 to 4,800 r, depending on the anterior-posterior diameter of the chest.

<sup>1</sup> From the Manhattan Veterans Hospital. Presented at the Forty-fourth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 16-21, 1958.

<sup>2</sup> Professor, Clinical Radiology, New York University College of Medicine; Consultant to the Manhattan Veterans Hospital.

<sup>3</sup> Assistant Clinical Professor of Radiology, New York University College of Medicine; Associate Radiologist, Manhattan Veterans Hospital.

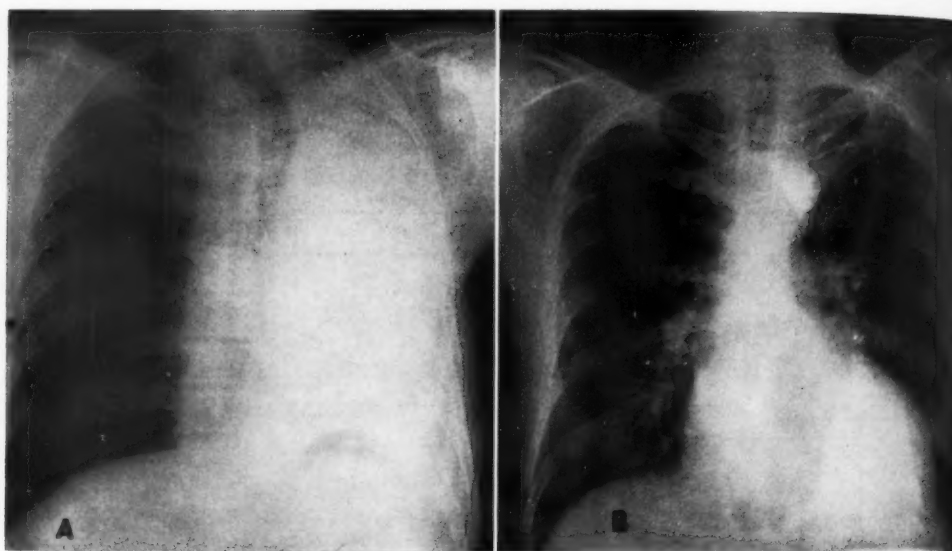


Fig. 1. A. Pre-irradiation: Note the complete opacification of the left hemithorax. The left lung is wholly collapsed, with retraction of the trachea, heart, and mediastinum to the left.  
B. Post-irradiation: The obstruction to the left lung has been relieved, with restoration of the thoracic structures to normal position.

Localization films were taken in each instance to verify the accuracy of the treatment portals.

The choice of a tumor dose of 3,000 r in a two-week period requires explanation. Generally, a tissue dose of 6,000 r in four to six weeks is considered curative therapy for cancer. The aim was to shorten the overall treatment time, which is justifiably indicated in palliative therapy. A fourteen-day period was chosen arbitrarily, in keeping with Paterson's expression of time as, "the shortest time which will be adequate to the task on hand, yet which will not produce immediate general effects on the patient" (3). Furthermore, in accord with the same author, who advises that at least half of a curative dose be given in palliative therapy, 3,000 r was deliberately chosen.

The ages ranged from thirty-nine to seventy-three years. Thirty-five patients, or 81 per cent, were between fifty and seventy, the expected peak of incidence of bronchogenic cancer. All tumors, specimens of which were obtained by bronchoscopy, thoracotomy, or lymph-node

biopsy, were histologically confirmed:

Carcinoma.....	24
Squamous-cell.....	8
Undifferentiated.....	7
Oat-cell.....	2
Adenocarcinoma.....	2

Of the group of 43 patients, all but 2 (95 per cent) had distant metastases detected clinically, roentgenographically, or at thoracotomy. Many patients had distant metastases in multiple sites. The areas of metastasis were:

Mediastinal nodes.....	18 cases
Bones.....	7 cases
Supraclavicular nodes.....	7 cases
Liver.....	6 cases
Laryngeal paralysis.....	6 cases
Pleural effusion.....	5 cases
Brain.....	4 cases
Superior vena cava syndrome.....	2 cases
Skin.....	2 cases
Esophagus.....	1 case
Pericardium.....	3 cases
Aorta.....	2 cases

#### SUBJECTIVE IMPROVEMENT

Since five-year arrests are rare in lung cancer, subjective improvement may be

Fig. 2  
and hilar  
B. F.

used  
peptic  
subject  
matic  
be all  
Hemop  
Pain...  
Cough  
Dyspno  
Superior

Obj  
strate

F. B.  
month  
of bre  
chest.  
enopat  
Absen  
noted.  
collapse  
paraly  
comple  
Biopsy  
noma.  
the ar  
and of  
tasis cl  
return

F. 2

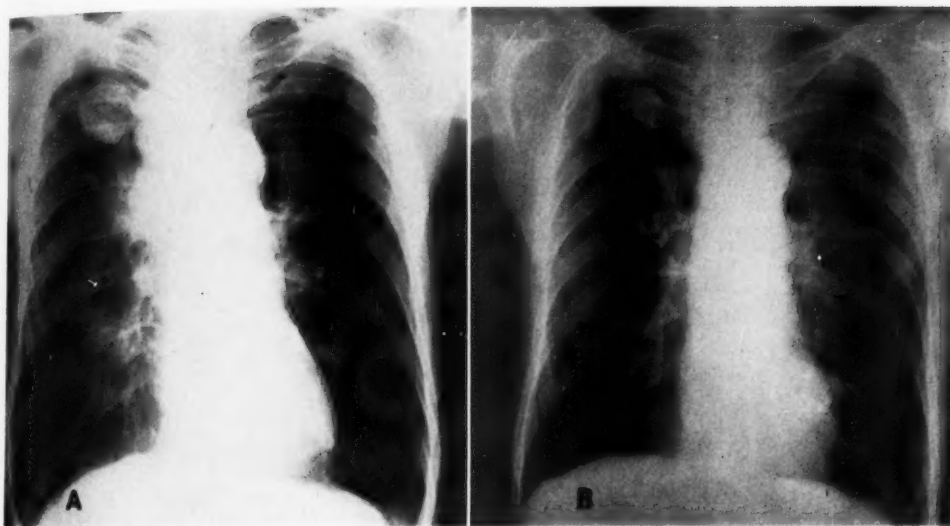


Fig. 2. A. Pre-irradiation: A rounded mass is noted in the right upper lobe. In addition, superior mediastinal and hilar masses are seen on the right.

B. Post-irradiation: The roentgenogram is essentially normal.

used as a biological assay of the therapeutic regime. In this series of patients subjective improvement was often dramatic. The most common symptoms to be alleviated were as follows:

Hemoptysis.....	15 cases
Pain.....	14 cases
Cough.....	10 cases
Dyspnea.....	5 cases
Superior vena cava syndrome.....	1 case

#### OBJECTIVE IMPROVEMENT

Objective improvement was demonstrated by x-ray studies in many patients.

F. B., a 57-year-old white male, had a sixteen-month history of hoarseness, hemoptysis, shortness of breath, nonproductive cough, and pain in the chest. Physical examination revealed no lymphadenopathy. The liver and spleen were not palpable. Absence of breath sounds in the left hemithorax was noted. The roentgenogram (Fig. 1, A) showed collapse of the left lung. Bronchoscopy disclosed paralysis of the left vocal cord and a fungating mass completely obstructing the left lower-lobe bronchus. Biopsy of the mass revealed squamous-cell carcinoma. An irradiation dose of 3,000 r was delivered to the area in two weeks and satisfactory subjective and objective palliation was achieved. The atelectasis cleared and the heart, mediastinum, and trachea returned to the normal position (Fig. 1, B).

F. Z., a 57-year-old white male, had an eight-

month history of cough, anorexia, and loss of weight. X-ray examination (Fig. 2, A) revealed large masses in the superior mediastinum and in the periphery of the right upper lobe. At bronchoscopy extrinsic pressure was seen on the right upper lobe bronchus. The scalene node biopsy showed carcinoma. Satisfactory subjective and palliative results were obtained with irradiation. The masses noted prior to therapy disappeared, and an essentially normal roentgenogram was obtained (Fig. 2, B).

W. H., a 50-year-old white male, complained of pain in the chest and cough of several months duration. The x-ray study (Fig. 3, A) revealed an irregular density in the lingular portion of the left upper lobe with a left hilar mass. The bronchoscope disclosed thickening of the superior segmental bronchus. A scalene node biopsy was positive for epidermoid carcinoma. After therapy the left hilar mass was no longer apparent, and the density in the left midlung field cleared considerably (Fig. 3, B).

W. M., a 59-year-old white male, had cough with blood-tinged sputum of several months duration. Roentgenograms (Figs. 4, A and B) showed a mass in the right lower lobe and right hilus. Bronchoscopic and cervicomedastinal node biopsies were positive for anaplastic carcinoma. Following therapy there was complete disappearance of the masses noted in the films taken prior to irradiation (Figs. 4, C and D).

E. R., the longest survivor in this series, was first seen in April 1956, complaining of irritation across the anterior chest, cough, bloody sputum, and a

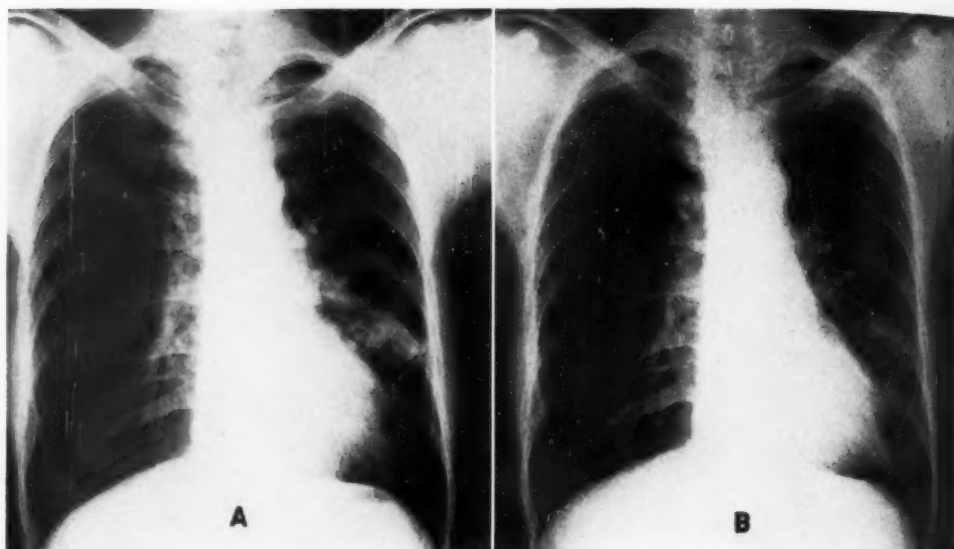


Fig. 3. A. Pre-irradiation: An irregular density representing a mass and/or obstructive pneumonitis in the lingular division of the left upper lobe is noted. A left hilar mass is likewise demonstrated.

B. Post-irradiation: The left hilar mass is no longer apparent, and the density has cleared considerably.

weight loss of 15 pounds in two months. The chest roentgenogram showed a mass in the posterior apical segment of the right upper lobe (Fig. 5, A). At bronchoscopy a large mass was seen in the right upper lobe bronchus, which was concentrically narrowed. The specimen was interpreted as carcinoma (unclassified) and a scalene node showed similar histology. The calculated tumor dose of 3,000 r was given with the factors previously outlined, from May 15 through May 28, 1956. The mass began to resolve soon after treatments were initiated (Fig. 5, B). Maximum skin effect with a moist second-degree reaction was recorded on the twenty-eighth day following completion of treatment. This reaction resolved without sequelae. The patient rapidly gained weight, his cough regressed, and the hemoptysis and chest pains disappeared.

The results observed in the 43 patients are as follows:

Subjective improvement.....	31 (72 per cent)
Objective improvement.....	17 (40 per cent)
No improvement.....	9 (21 per cent)

#### SURVIVAL

At the time of this evaluation 6 patients are living (Fig. 6) following completion of treatment:

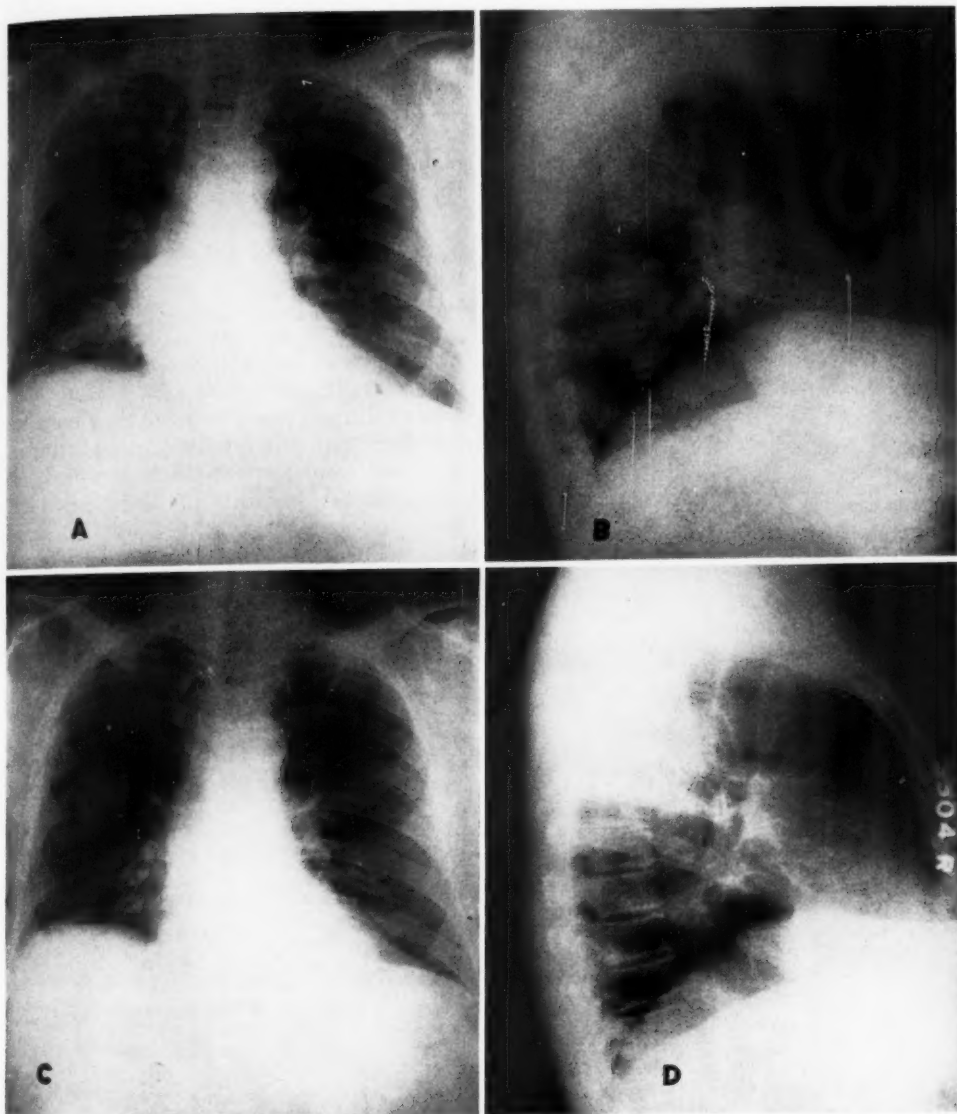
Two months after treatment.....	3 patients
Four months after treatment.....	1 patient
Five months after treatment.....	1 patient
Twenty-eight months after treatment..	1 patient

The length of survival of 37 patients from initiation of treatment to death is as follows:

One month.....	5 patients
Two months.....	9 patients
Three months.....	7 patients
Four months.....	4 patients
Five months.....	5 patients
Six months.....	2 patients
Seven months.....	1 patient
Eight months.....	1 patient
Ten months.....	1 patient
Twelve months.....	1 patient
Twenty-four months.....	1 patient

#### DISCUSSION

A technic which employs 250-kv therapy to deliver a tumor dose of 3,000 r into a lung cancer in two weeks is in no way presented as a substitution for super-voltage therapy. Recent reports in the literature indicate a superiority of high-energy radiation over conventional therapy. There is lack of agreement, however, as to preference of one energy range over another. The use of 1,000 kv has the support of Nickson and his group (4). Cobalt 60 has its advocates in Guttman (5) and Kutz (6). On the other hand, Watson (7) and



Figs. 4, A and B. Pre-irradiation: A circular mass in the right lower lobe and one in the right hilus are demonstrated.

C and D. Post-irradiation: Complete disappearance of the masses.

Haas and co-workers (8) write with greater enthusiasm about the betatron. Watson reported less favorable results after Cobalt 60 than after therapy with the betatron. Therefore, until time and experience establish more reasonable unanimity of opinion, and until supervoltage equipment becomes more universally available, technics with

conventional therapy should continue to be employed. A method, such as the one outlined in this presentation, has convincingly demonstrated its usefulness. It is worth noting that subjective improvement was obtained in 72 per cent of the group, and satisfactory objective changes, as noted in regression of tumors on the roentgenogram,



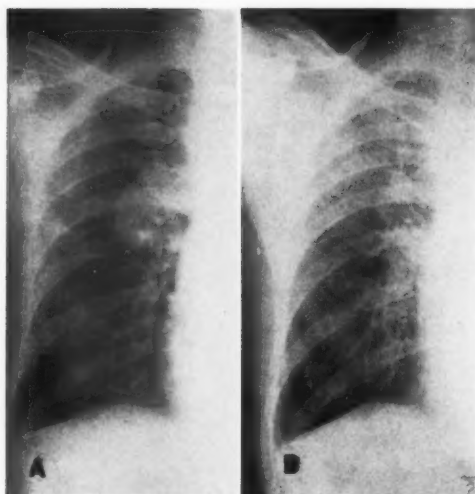


Fig. 5. A. Pre-irradiation: A mass is present in the right upper lobe.

B. Post-irradiation: The mass is no longer demonstrable. The horizontal fissure is minimally elevated.

were observed in 40 per cent. Indeed, these figures closely approximate those of Haas, who treated similarly advanced lung cancer with the betatron.

The short survival time of patients in

4.7 months, and the figures of others who report on advanced lung cancer. One patient (E. R.) living at the end of twenty-eight months is not unusual. This is well stated by Watson (7), who writes, "No one claims that radiation therapy is curative in this disease, although isolated five year survivals have been reported. Most of us, however, know of the occasional person who has survived five years without any treatment at all."

A time-dose pattern of 3,000 r in two weeks diminished the hospitalization period with its attendant cost. Many patients returned home to spend their remaining days with the family. In no instance was the treatment cycle interrupted or discontinued because of debilitation or other adverse reactions. Radiation sickness appeared in the same incidence, more or less, as with other technics, and was controlled with the usual medications. The symptoms secondary to esophagitis and tracheitis were tolerated and minimized with suitable measures.

As a consequence of using only anterior and posterior portals, treatment planning

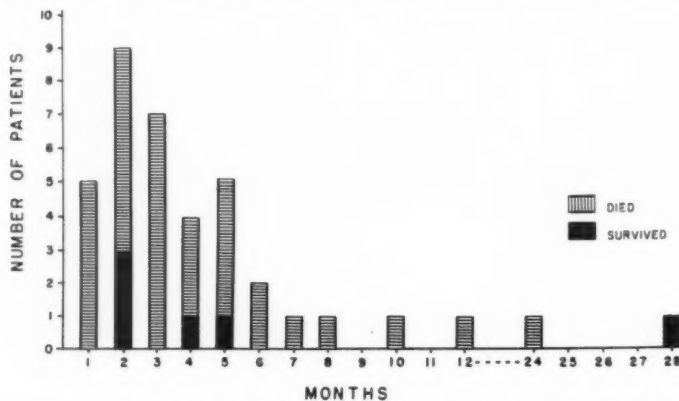


Fig. 6. Months of survival for 43 patients. Note that the greatest number did not survive beyond five months. The average survival of 5.1 months in the series includes patients still living.

this series is in keeping with the observations submitted in most reports. Thirty-seven patients survived an average of 4.3 months from the time of beginning treatment to death. Such survival figures approximate Nickson's 5.4 months, Kutz's

was facilitated, and complicated multiple-port techniques were not necessary. Like supervoltage, this procedure was easy on both the patient and the doctor. However, an opposing two-portal technic delivered a high dosage to the skin. The

majority of patients showed an intense secondary reaction, especially on the posterior portal. The curve in Figure 7 represents the median value of a scatter diagram of these reactions. The maximum moist reaction with skin denudation was reached between the fourth and fifth weeks and healed in all patients. Figure 8 depicts healed reactions on patient E. R. (see p. 673). Scar, telangiectasia, and induration are dominant features. Because skin reactions reached greatest intensity after full dosage had been given, there was no interruption of the treatment cycle.

#### CONCLUSIONS

1. Forty-three patients with advanced nonresectable cancer of the lung were treated with a specific time-dose pattern of 3,000 r in two weeks.

#### RADIATION REACTION CHART

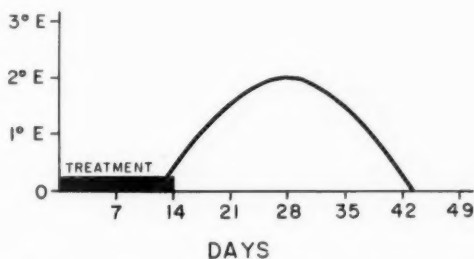


Fig. 7. Curve representing average skin reaction derived from plotting all reactions on a master chart. The skin change reached its greatest intensity about the fourth week, long after treatments were completed. Healing occurred in all patients, usually by the seventh week.

duce serious debilitation. There was no need to interrupt treatments because of radiation sickness, tracheitis, esophagitis, or skin reaction.



Fig. 8. The skin healed without difficulty. Scarring, atrophy, and telangiectasia resulted from x-ray treatments. Note that the irradiation effect posteriorly was greater than anteriorly.

2. Symptoms were controlled in 72 per cent of the series. Objective improvement, mainly regression as noted roentgenographically, was observed in 40 per cent of the patients.

3. Six patients are surviving from two to twenty-eight months.

4. The average survival period for all patients at the time of this survey was 5.1 months.

5. An abbreviated time-dose pattern achieved satisfactory palliation, shortened the hospitalization period, and did not in-

NOTE: The authors express deep appreciation to Mr. Raymond Kahn for his assistance in collecting the material for this paper, and to the Medical Illustration Department of the Manhattan Veterans Hospital.

477 First Avenue  
New York 16, N. Y.

#### REFERENCES

1. COLLIER, F. C., ENTERLINE, H. T., KYLE, R. H., TRISTAN, T. T., AND GREENING, R.: The Prognostic Implications of Vascular Invasion in Primary Carcinomas of the Lung: A Clinicopathologic Correlation of 225 Cases with 100 Per Cent Follow-Up. *Arch. Path.* 66: 594-603, October 1958.

2. GARLAND, L. H., AND Sisson, M. A.: Results of Radiotherapy of Bronchial Cancer. *Radiology* **67**: 48-62, July 1956.
3. PATERSON, R.: The Treatment of Malignant Disease by Radium and X-rays. Baltimore, Williams & Wilkins Co., 1948.
4. NICKSON, J. J., CLIFFTON, E. E., AND SELBY, H.: Carcinoma of the Lung. *Am. J. Roentgenol.* **77**: 826-835, May 1957.
5. GUTTMANN, R. J.: Two Million Volt Irradiation Therapy for Inoperable Carcinoma of the Lung. *Cancer* **8**: 1254-1260, November-December 1955.
6. KUTZ, E. R.: Intensive Cobalt-60 Teletherapy of Lung Cancer. *Radiology* **71**: 327-334, September 1958.
7. WATSON, T. A.: Supervoltage Roentgen Therapy in Cancer of the Lung. *Am. J. Roentgenol.* **75**: 525-529, March 1956.
8. HAAS, L. L., HARVEY, R. A., AND MELCHOR, C. F.: Radiotherapeutic Experiences with Inoperable Lung Carcinoma. *Cancer* **10**: 280-297, March-April 1957.

## SUMMARIO IN INTERLINGUA

**Le Tractamento de Cancere Bronchogene con Radios X Conventional Secundo un Specific Schema de Tempore e Dosage**

Un gruppo de 43 patientes consecutive con histologicamente provate cancro del pulmon recipeva un uniforme radiotherapia palliative. Le factores esseva: Radios X de 250 kv, filtro Thoraeus II (0,4 Sn), spissitate de medie valor de 2,5 mm de cupro a un distantia de 50 cm, e un rendimento de 37 r per minuta in le aere. Le dimensiones del campo variava inter 10 per 10 cm e 10 per 15 cm. Omne le lesiones recipeva un calculate dose tumoral de 3.000 r in un intervallo de tempore de dece-quatro dies. In dependentia del diametro anteroposterior del thorace, le dose al pelle variava approximativemente inter 4.000 e 4.800 r. Pelliculas de localisation esseva obtenite in omne caso individual pro verificar le accuratia del portales de

tractamento. Iste abbreviate schema de tempore e dosage effectuava un grado satisfactori de palliation; illo reduceva le periodo del hospitalisation; e illo non causava un serie debilitation. Nulle interruption del tractamento esseva necessari in consequentia de morbo del radios X, tracheitis, esophagitis, o reaction cutanee.

Le symptomatas esseva subjugate in 72 pro cento del casos. Le melioration subjective esseva dramatic in multes del casos. Un satisfacente melioration objective, judicate roentgenographicamente, esseva presente in 40 pro cento del casos. Al tempore del presente reporto, sex del patientes vive, duo a vinti-otto menses post le completion del tractamento. Le superviventia medie pro le 43 patientes es 5,1 menses.



# Pulmonary Radiation Reaction: A Vital-Capacity and Time-Dose Study<sup>1</sup>

JAMES R. GISH, M.D., E. O. COATES, M.D., LUCILLE A. DuSAULT, A.B., and HOWARD P. DOUB, M.D.

**A**BNORMAL pulmonary changes following radiation therapy over the lungs have long been recognized and frequently described. The object of this paper is not a description of these well known changes, but rather a report of a study of the relationship of the time-dose aspect of radiotherapy to radiation-induced fibrosis and of pulmonary vital capacity as an index of lung function in those patients with fibrosis. Consideration will also be given to various clinical aspects of the problem.

## REVIEW OF LITERATURE

The earliest report in this country of pulmonary changes following roentgen-ray treatment of breast carcinoma was made in 1923 by Groover, Christie, and Merritt (1). In the ensuing years many articles appeared in the literature regarding the pathology, incidence, and radiographic findings, as well as the clinical picture of pulmonary damage after irradiation of the lungs.

In 1942 a comprehensive review of the effect of radiation on the lung was given by Warren (2). The pathology of radiation pulmonary reaction is very similar to that of inflammation. There are edema, congestion, inflammatory cell infiltration, desquamation of bronchial and alveolar epithelium, followed by regeneration. If the reaction is mild, the changes subside in a few weeks or months, leaving little or no residual evidence. In severe cases, the inflammatory changes become chronic and may persist for months or years. During this period, fibrosis and excessive proliferation of connective tissue predominate.

Widmann (3) and McIntosh (4) suggested that age, arteriosclerosis, previous infection, or metastasis are contributing factors in the severe pulmonary reaction.

The symptoms of pulmonary radiation

reaction are varied. Many people present no symptoms. Some have a cough and chest pain. Rarely, one finds a patient with malaise, fever, and dyspnea. Congestive heart failure has been reported after several years of chronic progressive pneumonitis by Freid and Goldberg (5).

Leach (6) in 1943 reported that patients with chronic "pleuropneumonitis" following irradiation had "increased ventilation rate, a reduced complementary phase of vital capacity, and a low oxygen absorption." Whitfield, Bond, and Arnott (7) stated that "maximal breathing capacity and divisions of lung volume were both reduced, though the ratio of various divisions of lung volume to total capacity was much the same as in normal persons." One patient's arterial blood was studied and oxygen saturation was found to be normal at rest but desaturation became evident on exercise. Stone, Schwartz, and Green (8) observed 5 cases of radiation pneumonitis and fibrosis leading to severe pulmonary insufficiency. In some cases the residual air was normal and in others it was decreased. Some cases showed markedly reduced vital and total capacities. The intrapulmonary mixing was normal. Ventilatory and gas exchange studies in 2 patients were performed, revealing changes characteristic of impairment of alveolar-capillary oxygen diffusion.

## MATERIAL

The patients in this study received radiotherapy in the Henry Ford Hospital (Detroit) from July 1955 to the middle of 1958. One hundred and thirty-four cases in which the lungs received incident radiation during therapy to the mediastinum, lungs, and node-bearing areas of the chest wall were reviewed. All cases with inadequate radiologic and clinical follow-up were

<sup>1</sup> From the Henry Ford Hospital, Detroit, Mich. Presented at the Forty-fourth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 16-21, 1958.

discarded. In addition, 45 cases of pulmonary fibrosis, in which the time-dosage figures were available, were taken from the literature.

#### DETAILS OF STUDY

All patients were studied prior to radiotherapy for any evidence of earlier pulmonary disease in order to evaluate later changes. After completion of radiotherapy, these same patients were examined roentgenographically once a week for a month, at monthly intervals for six months, and at three-month intervals for a year, if no reactions were found. In those cases in which reactions appeared, vital capacity studies were made, and these patients were followed roentgenographically until the lesion became static. The pulmonary radiation reactions were classified as follows:

- I. Pleural reaction only.
- II. Pneumonitis—soft fluffy lesion, usually clearing within six months.
- III. Pneumonitis clearing in from six months to a year and leaving moderate linear fibrotic residue.
- IV. Pneumonitis, clearing in from six months to a year and leaving extensive fibrotic residue.

#### RADIATION TECHNIC

Two qualities of radiation were employed: (a) roentgen therapy with a h.v.l. of 1 to 3 mm. Cu and a target-skin distance of 50 cm.; (b) cobalt teletherapy with a source-tumor distance of 75 cm.

The maximal dose to the lung varied from 2,000 r in five days to 6,000 r in eighty-two days in the cases treated at the Henry Ford Hospital and from 1,700 r in twelve days to 8,200 r in thirty days in those collected from the literature.

The large majority of our patients were being treated for carcinoma of the breast and in all of these radiotherapy was given to the axillary and supraclavicular node-bearing areas. In addition, many patients received radiotherapy to the mediastinal nodes and some were also given

tangential irradiation to the chest wall. In the remainder therapy was directed to the mediastinum for esophageal carcinoma and other mediastinal tumors. In all patients an effort was made to avoid direct irradiation of the lungs.

#### PULMONARY FUNCTION STUDIES

Measurements of the total and three-second vital capacities were made prior to treatment and three months thereafter in 24 patients, most of whom were studied again six and twelve months later. A reduction of 10 per cent or more in total vital capacity was found in 9 instances (38 per cent) and a similar decrease in three-second vital capacity in 11 cases (46 per cent). These alterations were not large in any case; the maximal reduction in total vital capacity was 18 per cent, that in three-second vital capacity 22 per cent. In most instances, the changes were present three months after the beginning of radiotherapy. None of the 24 patients studied in this way showed any clinical signs of impaired pulmonary function.

More detailed studies were performed in 2 previously treated patients with roentgen evidence of extensive pulmonary fibrosis. In both, exercise tolerance and overall pulmonary function were surprisingly good.

#### RADIATION REACTIONS

In making a roentgen diagnosis of pulmonary reaction to irradiation it is necessary to have information regarding the previous status of the lungs, and the details of radiation received. Other disease processes may produce an appearance similar to that of radiation damage.

Lung changes produced by radiation may be homogeneous but more often are linear and of irregular density. In some instances there is only pleural reaction. In mild cases the reaction clears in a few weeks or months. With more severe involvement the changes progress for a few months and then gradually regress, leaving a small band of density in the lung as the end-result. With extreme reaction the final result is an area of dense fibrosis and



sometimes an accompanying distortion of the mediastinal and diaphragmatic structures.

The incidence of radiation pulmonary change naturally varies with the character of the reaction, as well as with the physical factors used. Leach, Farrow, Foote, and Wawro (10) in 1942 reported a 22.1 per cent incidence of roentgenographic evidence of pneumonitis in patients receiving radiation therapy for carcinoma of the breast. Widmann (3) found roentgen evidence of pulmonary fibrosis in 22 per cent of his cases; McIntosh and Spitz (4) gave the incidence of radiation pneumonitis as 60 per cent. Chu *et al.* (9), in a series of cases treated tangentially, at 250 kv, reported the incidence of pneumonitis as 6.6 per cent; at 1,000 kv the figure was 24.5 per cent. (The latter cases were treated more directly and with higher doses than the 250-kv treated cases).

In our series of patients who received 250-kv roentgen therapy, evidence of pleuropulmonary reactions was demonstrated in 44 per cent. The changes showed some degree of permanence roentgenographically. In 20 per cent of those patients who received cobalt-60 therapy, pleuropulmonary reactions developed. It is to be noted that the latter in general received a higher tissue dose than did those treated with roentgen rays.

In 10 patients who were treated over the mediastinum and medial borders of the lungs, pleuropulmonary reactions were observed in 1. This may not be significant, as there were fewer cases in this group and also the early changes were not as readily detected. In 18 of 44 patients whose lungs were exposed peripherally, some degree of pleuropulmonary reaction was demonstrated.

There were few instances of pleuropulmonary reaction in patients irradiated tangentially. This was also noted by Chu *et al.* The size of the field also seemed to influence the incidence of pleuropulmonary reaction. In those patients in whom a 10 × 20-cm. port or larger was used there was a reaction incidence of 44

250 KV	44 %	quality	Co <sup>60</sup>	20 %
peripheral	41 %	area of lung	medial border	10 %
10 x 20 cm or larger	44 %	field size	10 x 15 cm or smaller	22 %

Fig. 1. Pleuropulmonary reactions.

per cent, while in those in whom a port of 10 × 15 cm. or smaller was employed, the incidence was 22 per cent (Fig. 1).

#### TIME-DOSE STUDY

For the time-dose study all patients whose films showed lung changes designated as III or IV at any time during the series, regardless of earlier classifications, were combined to form a group representing permanent residual fibrosis. The remainder, whose films were never graded higher than I or II, were grouped as cases of temporary reaction only. The time-dose data for each group were plotted on log-log paper, and a line representing the incidence of fibrosis was drawn below those points in the first group (Fig. 2). The dose level at twenty-nine days seems fairly definite, but, because of the scarcity of points for longer periods, the slope is regarded as somewhat tentative. It is slightly greater than that for tolerance on the part of any other normal tissue so far found. If it proves valid, it would indicate that protraction of the overall time of treatment is of greater value in the prevention of lung fibrosis than of most complications of radiation therapy.

With the number of cobalt patients, and with the dose distribution used, no distinction in results could be made between 250-kv and cobalt-60 therapy, although most of the points above the line (Fig. 2), which indicate temporary reaction only, are from the cobalt group. The incidence of pulmonary reaction as previously described, 44 per cent for roentgen rays and 20 per cent for cobalt, suggests that the time-dose line for roentgen therapy may be lower.

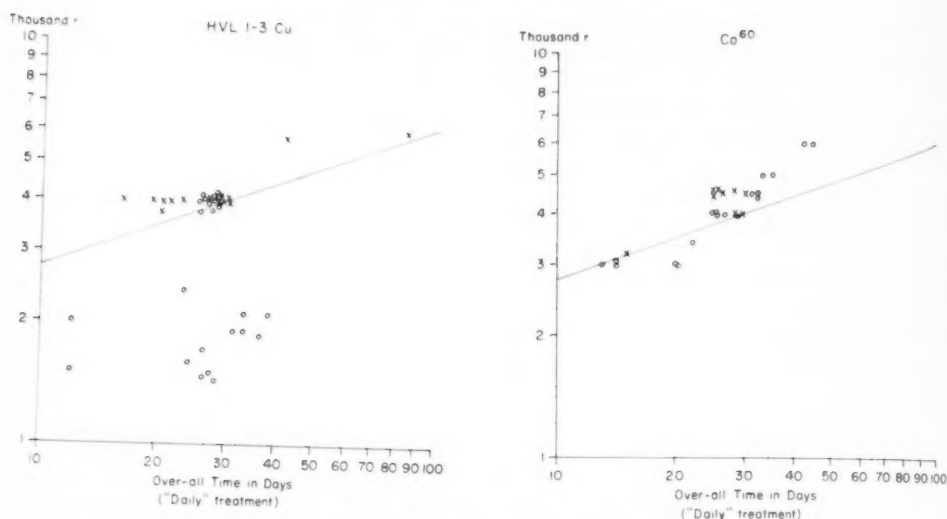


Fig. 2. Time-dose lines for minimal production of lung fibrosis for roentgen therapy (1-3 mm. Cu h.v.l.) and  $\text{Co}^{60}$  teletherapy. (Circles represent temporary reaction only, crosses represent permanent residual fibrosis.) Because there are no points immediately below the line in the chart of the roentgen study, it is impossible to determine whether this line should be lower than shown.

The lung tolerance line shown here holds only for treatment technics similar to that used in treating these patients, as described above. In a review of the literature, time-dose values consistent with this lung-tolerance line were reported when similar technics were used; with other technics there was fibrosis following widely scattered time-dose combinations.

#### DISCUSSION

The pulmonary roentgen changes which developed in patients of this study rarely involved more than one-third of the lung and were usually found in the upper portion. In most instances they represented a reversible radiation pleuropneumonitis.

The symptomatology in those cases showing the more pronounced pulmonary changes was not very severe. A few patients complained of moderate cough, tightness of the chest, and mild dyspnea during the peak of the reaction period. These same patients, however, experienced few or no symptoms from the residual pulmonary fibrosis. The moderate reduction in total and three-second vital capacities which occurred after therapy in some cases was consistent with a mild degree of airway ob-

struction as well as with some pulmonary fibrosis. In this group this degree of change would not be expected to produce symptoms, unless considerable impairment of function had been present prior to treatment.

The time-dose line could not be tested for agreement with the change in vital capacity because all but 1 patient on whom this study was performed received doses lying on or above the line. Although the numbers of patients are too small for statistical significance, it is of interest that the 10 per cent (or greater) drop in vital capacity seems to correlate better with presence of disease in the patient, shown by later metastasis, than with reports of fibrosis on the film. This suggests the possibility that some, at least, of the reduction in vital capacity may be due to the disease rather than to radiation-produced fibrosis.

#### SUMMARY

A study has been made of the pulmonary radiation reaction with reference to the time-dose relationship. Vital capacity studies were made on patients who showed pulmonary reaction.

The vital capacity studies showed mild changes from the normal. None of these patients exhibited clinical signs of impaired pulmonary function.

In patients who received 250-kv roentgen therapy, 44 per cent showed some evidence of pleuropulmonary reactions. In those receiving cobalt-60 therapy, only 20 per cent showed pleuropulmonary reactions, although they received a higher tissue dose. The small degree of lung reaction is largely attributable to tangential therapy and modern methods of lung-shielding in routine cases.

#### REFERENCES

1. GROOVER, T. A., CHRISTIE, A. C., AND MERRITT, E. A.: Roentgen Pleuropneumonitis. *South. M. J.* 20: 153-158, February 1927.
2. WARREN, S.: Effects of Radiation on Normal Tissues. *Arch. Path.* 34: 917-931, November 1942.
3. WIDMANN, B. P.: Irradiation Pulmonary Fibrosis. *Am. J. Roentgenol.* 47: 24-36, January 1942.
4. MCINTOSH, H. C., AND SPITZ, S.: A Study of Radiation Pneumonitis. *Am. J. Roentgenol.* 41: 605-615, April 1939.
5. FREID, J. R., AND GOLDBERG, H.: Post-Irradiation Changes in the Lungs and Thorax. A Clinical, Roentgenological, and Pathological Study, with Emphasis on the Late and Terminal Stages. *Am. J. Roentgenol.* 43: 877-895, June 1940.
6. LEACH, J. E.: Abnormal Pulmonary Physiology as a Result of Chronic Irradiation Pleuropneumonitis. A Preliminary Report. *Am. J. Roentgenol.* 50: 772-778, December 1943.
7. WHITFIELD, A. G. W., BOND, W. H., AND ARNOTT, W. M.: Radiation Reactions in Lung. *Quart. J. Med.* 25: 67-86, January 1956.
8. STONE, D. J., SCHWARTZ, M. J., AND GREEN, R. A.: Fatal Pulmonary Insufficiency Due to Radiation Effect upon the Lung. *Am. J. Med.* 21: 211-226, August 1956.
9. CHU, F. C. H., PHILLIPS, R., NICKSON, J. J., AND MCPHEE, J. G.: Pneumonitis Following Radiation Therapy of Cancer of the Breast by Tangential Technic. *Radiology* 64: 642-653, May 1955.
10. LEACH, J. E., FARROW, J. H., FOOTE, F. W., JR., AND WAWRO, N. W.: Fibrosis of the Lung Following Roentgen Irradiation for Cancer of the Breast. A Clinical Study. *Am. J. Roentgenol.* 47: 740-747, May 1942.

James R. Gish, M.D.  
317 Goodhue Building  
Beaumont, Texas

#### SUMMARY IN INTERLINGUA

#### Reaction Radiational del Pulmon: Un Studio del Capacitate Vital e del Magnitudes de Dosage-Tempore

Esseva passate in revista le historias clinic de 134 patientes in qui le pulmones recipeva irradiation incidental durante le radiotherapia del mediastino, del pulmones, e de areas nodifere del pariete thoracic. In plus, 45 casos de fibrosis pulmonar in que le magnitudes de dosage-tempore esseva disponibile esseva prendite ab le litteratura.

Le radiation empleate esseva de duo qualitates: Roentgenotherapiea con un spissitate de medie valor de 1 a 3 mm de Cu e un distantia inter pecia de concentration e pelle de 50 cm e teletherapia a cobalt con un distantia inter le fonte del radiation e le tumor de 75 cm. Le dose maximal al pulmon variava inter 2.000 r in cinque dies e 6.000 r in octanta-duo dies in le casos del autores e inter 1.700 r in dece-duo dies e 8.200 r in trenta dies in le casos trovate in le litteratura. In omne le casos, le effortio esseva facite de evitar un irradiation directe del pulmones.

In le serie del autores, reactiones pleuropulmonar esseva demonstrate in 44 pro cento del patientes qui recipeva un roent-

genotherapiea de 250 kv e in 20 pro cento del patientes tractate con cobalt-60. Tal reactiones esseva presente in 1 ex 10 casos quando le tractamento esseva supra le mediastino e le margines medial del pulmon e in 18 ex 44 patientes in qui le pulmones habeva essite exponite periphericamente. Esseva constatate pauc casos de reaction post irradiation tangential. Il pareva que etiam le dimensiones del campo influentiava le reaction: Le incidentia esseva 44 pro cento post le uso de un porta de 10 per 20 cm e 22 pro cento post le uso de un porta de 10 per 15 cm. Le basse grado de reaction pulmonar es attribuite primariamente al therapia tangential e al methodos moderne de proteger le pulmon.

Le studio del capacitate vital monstrava leve deviationes ab le norma sed nulle signo clinic de injuria al function pulmonar. Le 10 pro cento o plus per que le capacitate vital esseva reduce in le patientes studiate pare esser melio correlationate con le presentia de morbo (evidentiate subsequentemente per metastases) que con le reportos roentgenographic de fibrosis.

## Accelerated Palliative Radiation Therapy of Bronchial Carcinoma with 250-kv Roentgen Rays<sup>1</sup>

W. L. DeGINDER, M.D.<sup>2</sup>, and B. K. LOVELL, M.D.<sup>3</sup>

SINCE THE FIRST English description of bronchial carcinoma in 1842, the dismal prognosis has been emphasized repeatedly. In the past few years reports from outstanding cancer treatment centers indicate extension to the mediastinum or spread in the blood stream in about 90 per cent of the victims of lung cancer by the time the diagnosis is established (8, 11, 18). Perhaps one-third of these lesions are nonresectable only because of local extension within the chest, but few authors show much optimism concerning the possibility of prolonging or saving life by means of radiation therapy even in this group (14, 20, 25). The very nature of the disease makes it certain that in most patients the malignant process is already beyond operative control by the time treatment is sought, and the major task will continue to be the improvement of palliative management of the large group which cannot be cured by complete surgical resection of tumor-bearing structures.

### BRIEF PALLIATIVE TREATMENT

Radiation therapy remains the most effective palliative measure against nonresectable lung cancer, but the duration of treatment and the suffering incidental to it must be subtracted from the limited time and capacity for enjoyment of life remaining to the patient, and in this accounting there must be some assurance that he will not *wish* that he had been neglected! These considerations alone warrant the shortest period of therapy that will diminish symptoms without unpleasant radiation reactions, but there are other justifications as well.

Prolonged fractionation is useful only where it will increase the ratio of tumor damage over tissue damage and diminish systemic effects such as leukopenia and vomiting. Cohen, DuSault, and others (5, 10) have indicated that in the treatment of some tumors prolonged fractionation may be a distinct disadvantage, possibly because the sensitivity of surrounding tissues may be accelerated during the last weeks of treatment so that the therapeutic ratio ceases to improve with time or, in some situations, because the initial recovery rate of the tumor may be higher than the normal tissue rate. Among the tumors in which prolonged fractionation may be disadvantageous are primary and secondary cancers of the lung. It has been shown in our hospitals, and by others, that bronchial mucosa and alveolar septa of normal lung undergo inflammatory changes in the second and third week of radiation therapy, with abrupt desquamation, infection, inflammatory congestion, and widespread loss of cilia (14, 17, 28). Secretions are abnormal, septic, and poorly mobilized. In lungs invaded by tumor we have learned to expect some degree of sepsis and these inflammatory changes become more aggressive in the second week of radiation therapy even during administration of antibiotics and corticosteroids. Prolonging treatment beyond this time may deliver a large portion of the absorbed energy into inflamed tissues, where ionization density is increased and cells are sensitized by inflammation, fever, and oxygen saturation. If treatment can be terminated at the end of two weeks and still produce palliative effects without dis-

<sup>1</sup> From the Department of Radiology, Dallas Veterans Hospital. Presented before the Texas Radiological Society, San Antonio, Texas, Jan. 24, 1958, as a Progress Report. Accepted for publication in December 1958.

<sup>2</sup> Formerly Radiation Therapist, Dallas Veterans Hospital, and Assistant Clinical Professor of Radiology, University of Texas, Southwestern Medical School. Now in Austin, Texas.

<sup>3</sup> Chief, Radiology Services of the Veterans Administration Hospitals of McKinney and Dallas, Associate Clinical Professor of Radiology, University of Texas, Southwestern Medical School.

trekking radiation sequelae, the patients may gain in terms of *results* and *time*.

#### TIME-DOSE RELATIONSHIPS

It is useless to describe a *dose* of radiation or of a toxic drug unless some time factor is expressed or implied. Time-dose relationships in radiation therapy were discussed by Quimby, Pack, MacComb, Witte, and others in the late 1930's and were brought forcefully to our attention by Charles Martin of Dallas about the

pharyngeal mucosa treated with a wide variety of time-dose factors.<sup>4</sup> Many of the surface dose estimates were crude, but time-dose parabolooids were plotted for similar end-effects and converted to straight line approximations on log-log paper as suggested by the work of Witte and popularized by Strandqvist in 1944. The scatter was disconcerting, particularly on the rectilinear paraboloid plots, but the crude log-log approximations seemed to indicate that the therapeutic ratio made

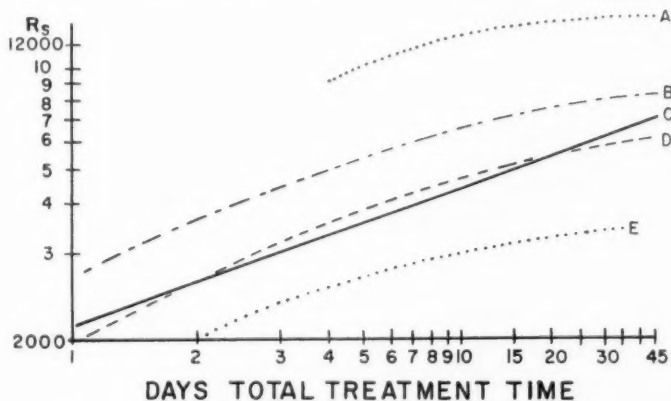


Fig. 1. Isoeffect curves: log-dose vs. log-time for a specific effect.

- A. Areas of less than 25 sq. cm.; necrosis, healed by scar formation.
- B. Areas 25 to 65 sq. cm.; severe moist desquamation with 10 per cent incidence of necrosis.
- C. The "skin tolerance" factors in a straight line approximation from Strandqvist, starting with log-1-day, designating a single treatment or the first of a series.
- D. The "skin tolerance" factors for 50 sq. cm., according to Paterson, extended to forty-five days with our data.
- E. Threshold for production of permanent pigment changes and epilation.

same time that Strandqvist was carrying on his studies in Stockholm (19, 26). The significance of the time factor was the topic of Martin's presidential address before the American Radium Society in 1947. His notable success in treating metastatic carcinoma of the cervical lymph nodes, delivering about 3,000 r of 250-kv x-rays (skin dose) and 6,000 r of radium gamma rays within a week, gave authority to his discussion and stimulated several of us in the area to re-evaluate short term therapy.

From four affiliated hospitals and two private clinics data were assembled regarding visible response of skin and oro-

pharyngeal mucosa treated with a wide variety of time-dose factors (Fig. 1).

The clinical *vs.* mathematical considerations of time-dose factors in changes of therapeutic ratio are still not in complete accord (1, 2, 5, 19, 26), but in 1949 we felt that a trial of short-term intensive treatment could be justified for bronchial carcinoma, and this was carried out at Parkland Hospital and the two affiliated Veterans Administration Hospitals, with the use of the

<sup>4</sup> Assembled through the aid of radiology residents at the Veterans Administration hospitals, Parkland Hospital, Baylor Hospital, and personal communications with Charles L. Martin, M.D., and J. R. Maxfield, M.D., of Dallas, Texas.



recently published data of Paterson to predict skin tolerance (21).

#### CLINICAL MATERIAL

In the last months of 1949, 23 patients with radiographically demonstrable tumor were selected for treatment and observation of objective changes. Skin doses ranged from 2,000 r in eight to twelve days up to 4,500 r in fourteen days according to the technic described below. These patients were followed until all were dead at the end of four years, and no contra-indication to accelerated therapy could be found. By the end of 1954 *all* lung cancers referred for radiation therapy at the Dallas and McKinney Veterans Administration Hospitals were treated in two weeks or less, including some metastatic tumors not reported here. Since 1946, approximately 560 patients have received 230-kv or 260-kv palliative therapy for primary bronchial carcinoma in these two hospitals. With the aid of a Veterans Administration research grant, the clinical records of 487 of these have been abstracted onto punch cards especially devised for this purpose. Patients with unconfirmed diagnosis were not tabulated in the survival report, and it was found necessary to drop others from the study because of incomplete follow-up or "lost" records. Other exclusions are noted in Table I. Since 1956, patients with very thick chests have been referred for treatment with Co<sup>60</sup> and these are not included. Also excluded are those that were treated only for distant metastases. Thirty-nine patients died during therapy, or within four weeks of its institution, representing an error of selection rather than a failure of therapy, but those who got more than half of the intended dose are included in survival statistics as "treatment failures."

Several fascinating incidental findings may be mentioned without any intended etiologic or prognostic meaning. Obviously, there is selective bias in this particular group of ex-service men. Every one of the 487 men had smoked an average of at least one pack of cigarettes per day

TABLE I: MATERIAL STUDIED

<i>Clinical Material</i>	
Received radiation therapy for nonresectable bronchial carcinoma.....	568
Treated for distant metastases only.....	35
No cytologic proof of diagnosis.....	28
Died within four weeks of start of therapy with less than half intended dose given.....	39
Treated with Co <sup>60</sup> teletherapy.....	14
Recently lost to follow-up.....	6
Tabulated for comparison.....	446
<i>Crude Histological Classification</i>	
Definite squamous-cell carcinoma.....	350 (78%)
Undifferentiated, unclassified.....	54 (12%)
Adenocarcinoma.....	27 (6%)
Alveolar-cell.....	15 (3%)

for nine years or more (average: fifteen years) although 35 per cent of the adult males of this region smoke rarely or not at all (20). The age distribution differs from that usually reported in that 27.5 per cent of the patients were less than fifty years of age and 10 per cent less than forty. The average age was fifty-two. Seventeen per cent of the group had multiple primary malignant growths. Two patients are known to have had four distinct varieties of primary cancer and several had three separate primary neoplasms. Simultaneous development of bronchial carcinoma in both lungs was noted. The association of neoplasms in the mouth, pharynx, larynx, and gastrointestinal tract with separate primary bronchial carcinoma may have some significance yet to be established.

No attempt has been made to group these patients according to cytological type or grade of tumor, or according to the stage of extension at the time of biopsy or exploration. Other authors have considered the effects of these factors in detail (4, 8, 9, 14, 25) but we are unable to demonstrate any convincing relationship to early or late results of radiation therapy. We present only the crude cellular classifications (Table I) to show the predominance of the squamous type. All cases had cytologic confirmation.

The clinical staging of bronchial carcinoma is inaccurate, even after thoracic exploration. Distant metastases found within a few weeks of "complete resections" are unhappy proof of this fact.

Clinical staging of our cases may be described bluntly: Nonresectable. One hundred and seven tumors had been declared nonresectable following exploration (this includes those referred to elsewhere in this paper with incomplete resection). All cases not explored were nonresectable by reason of signs of direct intrathoracic extension or distant metastases. Radiation therapy for relief of bronchial obstruction, distressing cough, pain, hemorrhage, or the secondary symptoms of mediastinal invasion was the same regardless of cell type. Some cases of adenocarcinoma showed prompt response, and a few highly undifferentiated tumors seemed refractory, but we do not have the data to suggest the reasons.

Eighty-four patients were eventually proved to have had incomplete excision of tumor.<sup>5</sup> While this procedure is easily justified when it is done to remove segments of productive purulent bronchiectasis or necrotic abscesses, both quite refractory to radiation therapy, other indications for proceeding with an incomplete resection through malignant tissue deserve very deliberate consideration (8, 9). Separate statistical evaluation of this group is not attempted, but it may be pointed out that some postoperative deaths occurred during treatment or immediately thereafter, accounting for a considerable proportion of the early mortality following accelerated palliative radiation therapy.

#### ACCELERATED PALLIATIVE RADIATION THERAPY

Where palliation is the aim, the skin dose and the tumor dose must represent a compromise designed to produce the maximum tumor effect in the limited available time without producing painful sequelae in skin, pleura, or lung. Our dose limit has been established at the predicted moist-desquamation threshold dose for the skin area, time factor, and other technical

factors of exposure in each case. The threshold dose for moist desquamation was first predicted from the skin tolerance curves for x-rays of 1.5 mm. Cu h.v.l. published by Paterson in 1949 (21); later from log-log curves similar to those in Figure 1, after it was found that the threshold was almost 10 per cent higher at the eight-day and fourteen-day intervals with h.v.l. of 2.5 mm. Cu. In some ways the Paterson graph is superior for this purpose exactly as published, providing a slight safety margin at 2 to 2.5 mm. Cu h.v.l. and presenting time-dose-area data in a way that leaves little excuse for misinterpretation.

Several attempts have been made at intervals to measure or calculate the exit dose through the thorax in order to approach greater accuracy in the estimation of the total skin doses and the dose to the hilus or central tumor, but the irregularities observed in these experiments, the nonavailability of a physicist, and the difficulties imposed by the sustained work-load on our small staff convinced us that it would be best to avoid all steps that might multiply human error in treatment planning. The contributions of the entry dose and exit dose were therefore *estimated* according to standard scatter tables and isodose curves. (It would be unseemly to glorify this procedure by any term that might imply exactitude, no matter how accurate the arithmetic has been.) Backscatter to the skin of the exit portal was intentionally avoided so that the actual surface dose would not perceptibly exceed the estimates based on standard curves without compensation for the diminished absorption in aerated lung.

The dose to the hilus, mediastinum, or central tumor has been estimated on the same basis, assuming that it is relatively unimportant if the central dose may be actually 10 per cent higher (16). Much more significant is the fact that the desired skin reaction was produced quite reliably. In the first 200 skin areas tabulated, deep erythema with central patches of moist desquamation was obtained in 84 per

<sup>5</sup> The patients with incomplete resection had radical surgery because all available data indicated that an attempted cure by surgical removal might be possible. Those that did *not* have incomplete surgical resection either had contraindications to the surgical attempt, or had a successful attempt!

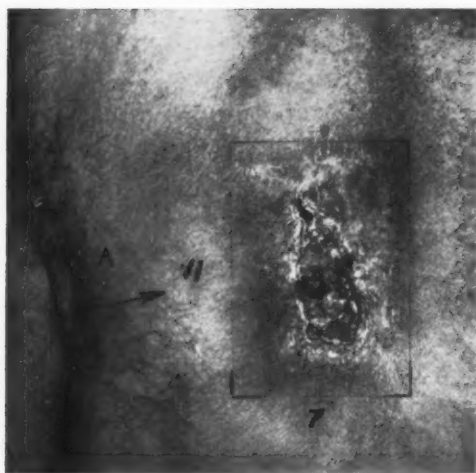


Fig. 2. The only example of necrosis developing in a skin area. The skin over the scapula failed to heal after a skin dose of 4,500 r delivered in thirteen days.

cent of the areas on the anterior chest wall, and 76 per cent of those on the posterior surface, with the rest showing lesser grades of erythema. Considering this a sign of higher tolerance for the dorsal skin, a 10 per cent increase of tolerance dose was accepted in some of the later treatments. This variation from the standard skin tolerance curve, plus the addition of a small axillary portal, possibly accounts for the only instance of skin necrosis. Of 1,117 skin areas treated, only 1 failed to heal completely within eight weeks of termination of treatment. In this patient (Fig. 2) central necrosis developed in a dorsal skin area given 4,500 r in twelve days elapsed time, but he allowed it to heal slowly from the margins rather than submit to skin grafting. He is at home, still living, more than a year following treatment for histologically proved cancer so extensive that exploration was not even considered.

In all of these patients treatment was directed to tumor radiographically visible or marked with silver hemostatic clips by the surgeons, with the intention of concentrating a relatively high dose of radiation in a mass producing obstruction of an airway or vascular structures or thought to be responsible for pain, distressing cough,

vocal paralysis, or dysphagia. In a few instances we treated tumor *threatening* immediate bronchial obstruction. No attempt was made to include the entire zone of probable extension, but this may have been accomplished quite by accident in our few cases of prolonged survival (Table II).

TABLE II: SURVIVAL FROM START OF RADIATION THERAPY

Number	Years Survival	Still Living
Conventional Plan (Estimated tumor dose 2,000 to 6,000 r in three to six weeks elapsed time)		
1	6	1
4	4	0
10	3	0
16	2	2
33	1	2

50% of the remaining 142 were dead at 4.8 months from the start of therapy; 19% survived one year.

Accelerated Palliative Therapy (Estimated tumor dose 1,500 to 3,200 r in eight days or two weeks); cases followed more than one year (includes 28 patients who received more than half intended dose but died within four weeks of start of treatment)\*

1	4	1
3	3	1
12	2	8
42	1	18

50% of the remaining 158 were dead at 5.2 months from the start of treatment. 21% survived one year or more.

\* Certain features of selectivity in the first two years of this project placed some of the least favorable cases in the accelerated therapy group. This is discussed in the text.

Two opposing portals of about 100 sq. cm. proved adequate for most tumors of the large bronchi or the lung root, but three portals of about the same area afforded a better distribution of radiation into the mediastinum. It is important to mention that no single skin portal exceeded 200 sq. cm. in the group treated in two weeks or less; these were elongated areas of 9 × 22 cm., or similar rectangles, which tolerate more than the same area exposed as a circle or a square.

Space will not permit subclassification according to minor variations of treatment plan, but since the total x-ray dose was based on the predicted moist-desquamation threshold, "average" treatments may be described: Factors were 250 kvp, 2.5 mm. Cu h.v.l., 50 cm. target-skin dis-

Fig. 3.  
neck.  
celerate  
C and  
D show

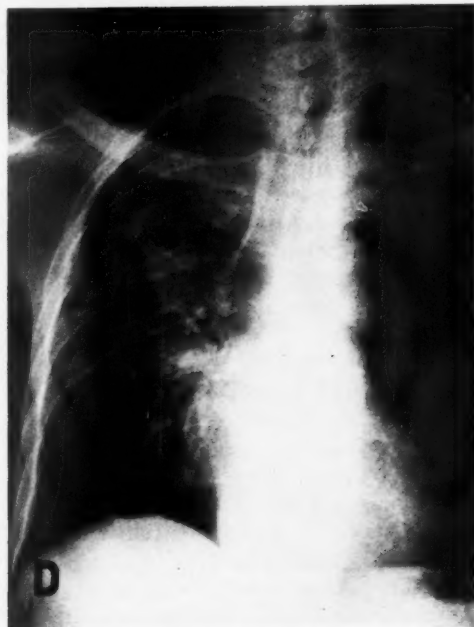
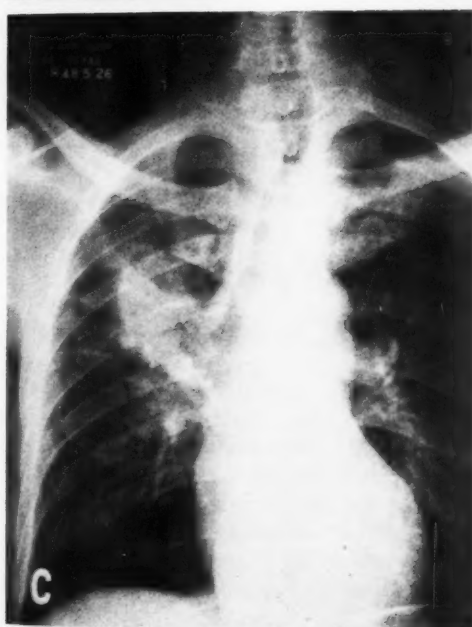
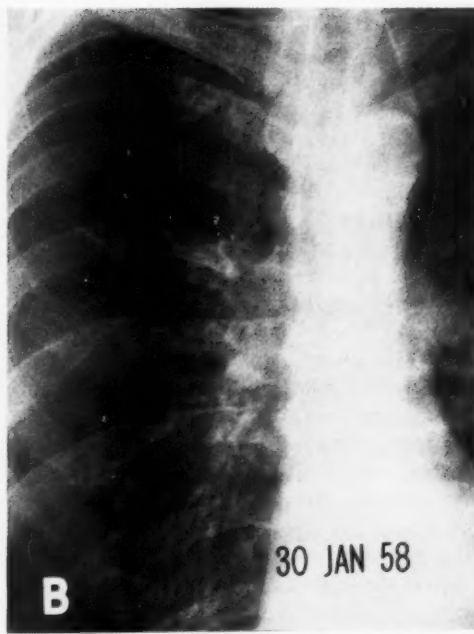
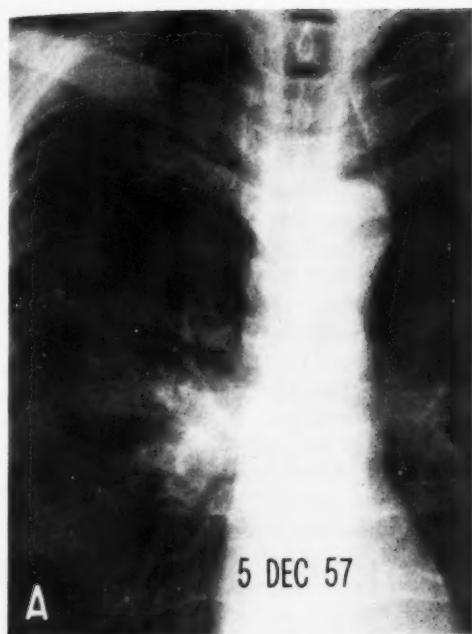


Fig. 3. A and B. R. T.: Squamous-cell carcinoma extending along the right side of the trachea into the neck. Superior vena cava obstruction. Film of Jan. 30 shows objective improvement three months after accelerated treatment.

C and D. H. C.: Extension of malignant process into lung root and carina with hemoptysis and cough. D shows objective improvement that accompanied eradication of these symptoms for more than a year.



tance. Two opposite portals of  $9 \times 12$  cm. were used. In eight days elapsed time 3,600 r were delivered to each area in six treatments of 400 r (in air) each, or treatment was extended over fourteen days, with 4,000 r to each skin area in ten treatments of 260 r (in air) each. The exit skin dose without back-scatter was estimated to be 20 per cent.

Patients with symptoms and clinical signs of advanced disease were deliberately selected for the accelerated treatment. Some of these failed to live long enough to complete the treatment, since symptomatic improvement was obtained frequently enough to justify attempted palliation in some moribund patients. Those who received more than half of the intended tumor dose have been included in the survival figures. Accelerated palliative therapy was not used for patients with superior vena cava obstruction until 1954, when nitrogen mustard became available for preliminary use to obtain a reduction of tumor volume. While this improvement was of but brief duration without subsequent irradiation (12, 20, 23, 24), in association with the latter procedure the drug was found of value. It prevented the potentially disastrous complication of inflammatory edema in the tumor following an intensive x-ray exposure, and the subsequent accelerated palliative radiation therapy usually arrested tumor growth for months or years (Fig. 3).

#### RESULTS OF PALLIATIVE TREATMENT

Roswit and Kaplan collected data concerning almost 600 patients with unresected primary bronchial carcinoma *not* treated by any type of radiation and found that none survived more than a year from the onset of symptoms. Other authors have based similar survival studies on the duration of life from the date of diagnosis or the date of surgical exploration, but these dates are difficult to establish (20, 24, 25). The date of the first symptom is even more elusive.

To avoid the injection of such variables, the survivals in this report will be con-

sidered only in relation to the period of possible benefit from the palliative treatment, namely, that period beginning with the *institution of treatment*. The gross survival figures in Table II still compare favorably with any survival rates based upon earlier events in the natural history of primary lung cancer and certainly exceed the average life expectancy of untreated patients.

The tabulation of survival following treatment is a remote but positive measure of the symptomatic improvement obtained. The date of death is a specific event, but the varieties and degrees of symptomatic improvement are exceedingly vague. Karnofsky *et al.* (14, 15) have described a comprehensive method of defining and recording certain varieties of symptomatic improvement, but we have found it impossible to reconstruct such records from existing progress notes and hospital charts. Survival is extended only through some improvement of the patient's desire and ability to live, and it has been possible to produce this improvement without prolonged hospitalization or unpleasant sequelae. It is particularly significant that only 48 of the patients treated by the accelerated method were unable to return to home-care with family and friends within a month from the *start* of treatment, and 97 are known to have resumed work for some period of time.

The Radiation Therapy Service had ward space and full responsibility for the care of the patients at the Dallas Hospital during the period of x-ray treatment. The senior staff radiologist and the resident spent some time with each patient on the ward almost daily. Even in large institutions, the relationship to the incurable patient and his family becomes particularly intimate under these circumstances. We have been impressed with the amount of suffering produced by anxiety and the relief afforded by its suppression. In the subjective evaluation of palliative results, the patients rate the relief of anxiety and the creation of hope just beneath relief of pain in relative importance. A few pa-

tient  
ever  
situa  
ceiv  
of a  
pers  
effec  
may  
to b  
com  
sleep  
some  
men  
part  
awa  
not  
stat  
phys  
irrad  
of an  
thing  
subm  
card  
less

Ac  
Miller  
advise  
South  
reco  
mater  
Resea  
Hospi  
Medic  
Aust  
2410  
Aust

1.  
Dose-  
Roent  
2.  
of the  
1949.  
3.  
Betwe  
Meet.  
4.  
noma  
1957.  
5.  
I. Do  
ations.  
6.  
H.: C  
Tumor  
1956.



tients have rated the relief of dyspnea even higher than control of pain, and in this situation the subjective improvement receives a large contribution from abatement of anxiety. One virtue of the direct, personal doctor-patient relationship is the effect intimate trust and understanding may have. Increased confidence seems to be an active factor in the reduction of complaints, improvement of morale and sleeping habits, and the weight gain sometimes observed after accelerated treatment and early discharge from the hospital, particularly in patients who are quite aware of the fact that the treatment was not an attempt to cure. The survival statistics tell part of the story of the physical response to accelerated palliative irradiation, but how can we tabulate relief of anxiety for statistical evaluation? Many things related to the healing art do not submit themselves conveniently to punch cards or formulas, but this makes them no less important to the sick person.

**ACKNOWLEDGMENTS:** The assistance of Paul Miller, Southern Methodist University, statistical adviser, and of Jim Ketchersid, University of Texas, Southwestern Medical School in tabulation of clinical records, has played a vital part in preparation of this material. Supported in part by aid from the Research Committee of the Affiliated Veterans Hospitals and University of Texas, Southwestern Medical School.

Austin Radiological Group  
2410 Rio Grande  
Austin 5, Texas

#### REFERENCES

- ANDREWS, J. R., AND MOODY, J. M.: The Dose-Time Relationships in Radiotherapy. *Am. J. Roentgenol.* **75**: 500-596, March 1956.
- BACLESSE, F.: Roentgentherapy in Cancer of the Hypopharynx. *J.A.M.A.* **140**: 525-530, June 11, 1949.
- BERKSON, J.: Statistical Study of Association Between Smoking and Lung Cancer. *Proc. Staff. Meet. Mayo Clin.* **30**: 319-348, July 27, 1955.
- BUSCHKE, F.: Roentgen Therapy of Carcinoma of the Lung. *Radiology* **69**: 489-492, October 1957.
- COHEN, L.: Radiotherapy in Breast Cancer. I. Dose-Time Relationship: Theoretical Considerations. *Brit. J. Radiol.* **25**: 636-642, December 1952.
- COLLINS, V. P., LOEFFLER, R. K., AND TIVEY, H.: Observations on Growth Rates of Human Tumors. *Am. J. Roentgenol.* **76**: 988-1000, November 1956.
- COUTARD, H.: Results and Methods of Treatment of Cancer by Radiation. *Ann. Surg.* **106**: 584-598, October 1937.
- DAVIS, E. W., KATZ, S., AND PEABODY, J. W., JR.: Surgical Procedures in the Diagnosis and Treatment of Bronchogenic Carcinoma. *Am. J. Roentgenol.* **74**: 429-436, September 1955.
- DOTTER, C. T., STEINBERG, I., AND HOLMAN, C. W.: Lung Cancer Operability: Angiocardiographic Study of 53 Consecutive Proved Cases of Lung Cancer. *Am. J. Roentgenol.* **64**: 222-237, August 1950.
- DUSAULT, L. A.: Time-Dose Relationships. *Am. J. Roentgenol.* **75**: 597-606, March 1956.
- GUSS, L. W.: Mass Roentgenographic Screening as a Lung-Cancer-Control Measure. *Cancer* **8**: 219-236, March-April 1955.
- JACOBSON, L. F., AND KNAVER, I. S.: Correction Factors for Tumor Dose on the Chest Cavity Due to Diminished Absorption and Scatter in Lung Tissue. *Radiology* **67**: 863-876, December 1956.
- KARNOFSKY, D. A., ABELMANN, W. H., CRAVER, L. F., AND BURCHENAL, J. H.: Use of Nitrogen Mustards in the Palliative Treatment of Carcinoma with Particular Reference to Bronchogenic Carcinoma. *Cancer* **1**: 634-656, November 1948.
- KARNOFSKY, D. A., GOLBEY, R. B., AND POOL, J. L.: Preliminary Studies on the Natural History of Lung Cancer. *Radiology* **69**: 477-487, October 1957.
- KARNOFSKY, D. A., AND GOLBEY, R. B.: Design for Experimental Chemotherapeutic Studies. *Proc. 3d Nat. Cancer Conf.*, 1956. Philadelphia, J. B. Lippincott Co., 1957, p. 428. (Also personal communications.)
- KORNELSEN, R. O.: Tumor Dose in the Chest Cavity. *Brit. J. Radiol.* **27**: 289-293, May 1954.
- KOSS, L. G., AND RICHARDSON, H. L.: Some Pitfalls of Cytological Diagnosis of Lung Cancer. *Cancer* **8**: 937-947, September-October 1955.
- MCBURNEY, R. P., KIRKLIN, J. W., AND HOOD, R. T.: Asymptomatic Bronchogenic Carcinoma. *Ann. Surg.* **141**: 84-86, January 1955.
- MARTIN, C. L.: The Time Factor in Radiation Therapy. *Am. J. Roentgenol.* **59**: 1-8, January 1948.
- MAYER, E., AND ROSWIT, B.: Palliative Treatment of Nonresectable Pulmonary Neoplasms—Primary and Metastatic. *New York State J. Med.* **53**: 1647-1653, July 15, 1953.
- PATERSON, R.: The Treatment of Malignant Disease by Radium and X-Rays. Baltimore, The Williams & Wilkins Co., 1948, p. 39.
- RIGLER, L. G.: The Roentgen Signs of Carcinoma of the Lung. *Am. J. Roentgenol.* **74**: 415-428, September 1955.
- ROSWIT, B.: Present Status of Chemotherapy of Bronchial Cancer. *Radiology* **69**: 499-505, October 1957.
- ROSWIT, B., AND KAPLAN, G.: Nitrogen Mustard as an Adjunct to Radiation in the Management of Bronchogenic Cancer. *Radiology* **57**: 384-394, September 1951.
- SCHULZ, M. D.: The Results of Radiotherapy in Cancer of the Lung. *Radiology* **69**: 494-498, October 1957.
- STRANDQVIST, M.: Studien über die kumulative Wirkung der Röntgenstrahlen bei Fraktionierung. *Acta radiol. Suppl.* **55**, 1944.
- THOMAS, S. F.: Combined Therapy: Radiation and Chemicals. *Radiology* **69**: 204-207, August 1957.
- WARREN, S., AND SPENCER, J.: Radiation Reaction in the Lung. *Am. J. Roentgenol.* **43**: 682-701, May 1940.

(Pro le summario in interlingua, vider le pagina sequente)

## SUMMARIO IN INTERLINGUA

**Accelerate Radiotherapia Palliatori de Carcinoma Bronchial con Radios Roentgen de 250 kv**

Es describe un accelerate technica roentgenotherapeutic pro carcinoma bronchial. Omittente certe variationes minor, nos pote reportar que le factores in le tractamento medie esseva 250 kvp, spissitate de medie valor 2,5 mm Cu, e 50 cm distantia inter pecia de concentration e pelle. Duo portales opponite, de un dimension de 9 per 12 cm, esseva tractate. In un periodo de octo dies, 3.600 r esseva applicate a cata un del duo areas in sex tractamentos de 400 r (in aere), o le curso esseva prolongate a dece-quattro dies con 4.000 r a cata area in dece tractamentos de 260 r (in aere).

Es reportate le resultatos obtenite per

iste technica in un serie de pacientes con non-resectionabile cancro bronchial. Le cifras grossier de superviventia pro iste gruppo, calculate a partir del comenciamiento del therapia, es favorabile in comparison con cifras de superviventia pro terapias conventional, mesmo si iste ultimes es basate super plus precoce eventos in le historia natural del neoplasma. In plus, le alleviamento del symptomatos esseva obtenite sin prolongate periodos de hospitalisation e sin sequellas displacente. Un del beneficios—e certo non le minus importante—esseva le alleviamento del anxietate, con consequente melioration subjective.



S  
by  
Res  
The  
indi  
sizer  
mer  
rods  
usef  
resp  
and  
200  
accu  
met  
will  
of it

D  
T  
cons  
glas  
the  
ions  
capt  
from  
Whe  
viol  
an o  
silve  
part  
ions  
used  
In  
used  
rod  
Sinc

<sup>1</sup> P  
Nov.  
Th  
3605.  
Sub-o  
<sup>2</sup> L  
<sup>3</sup> V  
<sup>4</sup> B  
<sup>5</sup> P

# Radiation Dosimetry With Fluorods

## (Miniature Glass Rod Dosimetry)<sup>1</sup>

MORRIS HODARA, M.S.,<sup>2</sup> MILTON FRIEDMAN, M.D.,<sup>3</sup> and GERALD J. HINE, Ph.D.<sup>3</sup>

SEVERAL YEARS ago a radiation-sensitive glass was originated and developed by Schulman and others at the Naval Research Laboratory, Washington, D. C. They established its usefulness as a dose indicator (1-5) and developed it in several sizes and shapes, one of which is now commercially available in the form of miniature rods. The glass rod dosimeter is especially useful in the supervoltage range, where its response is relatively energy-independent and where medically significant doses of 200 to 400 r can be measured with an accuracy of about 5 per cent. The dosimetric properties of the glass rod dosimeter will be described in detail and examples of its practical usefulness presented.

### DESCRIPTION OF THE FLUOROD AND FLUORIMETER

*The Fluorod:* The glass rod dosimeter consists of silver-activated phosphate glass. The silver is in ionic form. When the rod is irradiated, some of the silver ions are converted into silver atoms by capturing electrons which have been ejected from the glass by the ionizing radiation (4). When subsequently irradiated by ultraviolet light, the silver atoms glow with an orange fluorescence. The unconverted silver ions do not fluoresce in the orange part of the spectrum. The number of silver ions converted to atoms can therefore be used as the measure of dose.

In our studies, the glass dosimeter was used exclusively in the form of a miniature rod 1 mm. in diameter and 6 mm. long.<sup>4</sup> Since its fluorescent properties serve for

dose measurements we will call it a "fluorod."

The small dimensions and chemical inertness of the fluorod make it an ideal dosimeter for many clinical radiation therapy problems. A great number of fluorods can be dispersed simultaneously in a phantom or taped on the skin surface of a patient without disturbing the radiation field. Furthermore, a few fluorods can be positioned accurately in body cavities within the treatment area, inside catheters or by packing into the cavities. The fluorods may be enclosed in thin Teflon or plastic tubing for convenience in positioning and to avoid contamination by foreign fluorescent materials. The difficulties experienced with miniature ionization chambers, such as loss of electric charge and breakage of weak chamber walls, are not encountered with fluorods.

*The Fluorimeter:* The orange fluorescence of the converted silver atoms in the fluorod when excited by ultraviolet light is used as a measure of the absorbed radiation dose. Since this fluorescence is faint, a highly sensitive instrument is required to measure it accurately. A fluorimeter,<sup>5</sup> originally developed for chemical photometry, proved to have the required properties. It consists basically of a mercury arc lamp as a source of ultraviolet light, a slit system, a photomultiplier tube as detector of the fluorescence, and a microammeter to measure the current output of the photomultiplier tube (1P21). In order to position the fluorods in the ultraviolet beam of the instrument, a special

<sup>1</sup> Presented at the Forty-fourth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 16-21, 1958.

This investigation was supported by the National Cancer Institute, U. S. Public Health Service, Grant C, 3605-Rad (A), and C-4282 Rad; also by the U. S. Atomic Energy Commission Contract No. AT-(40-1)-GEN-33-Sub-contract No. 21.

<sup>2</sup> Lila Motley Radiation Therapy Department, Hospital for Joint Diseases, New York, N. Y.

<sup>3</sup> Veterans Administration Hospital, Boston, Mass.

<sup>4</sup> Bausch and Lomb Optical Co., Rochester 2, N. Y.

<sup>5</sup> Photovolt Model 540, Photovolt Corporation, New York.

holder was designed by the Physics Department of the Sloan-Kettering Institute in New York.

A primary light filter (Corning 5860) is positioned between the mercury arc lamp and the entrance slit of the fluorod holder. This filter transmits only ultraviolet light of the 3,650 Å line of the mercury arc. A secondary filter combination (Corning 3484 and 4784) is positioned between the exit slit of the fluorod holder and the photomultiplier tube. This combination filter, which transmits only a narrow band around

No use is made of the two ends of the fluorods since they are most liable to slight irregularities such as scratches and chips.

The fluorod holder consists of a pick, into which the fluorod fits tightly, and a small metal block into which the pick is inserted (Fig. 1). This holder fits in the fluorimeter where ordinarily the cuvette is placed. The ultraviolet light enters the metal block through the slit at the front surface, and the fluorescent light escapes through the slit on the top surface. All

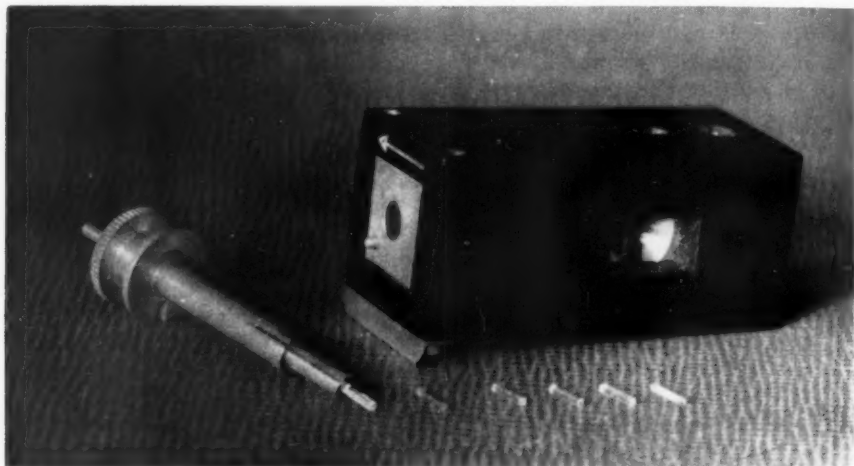


Fig. 1. Fluorod holder consisting of a pick with a fluorod (on the left) and a block into which the pick is inserted. The entrance slit for the ultraviolet light is on the front surface of the metal block, and the exit slit for the fluorescent light is on the top. Ordinarily the fluorod is inserted completely into the barrel of the pick. The two openings at the end of the pick, only one of which is visible in the figure are coincident with the slits in the metal block when the pick is in place.

5,500 Å, effectively reduces the background fluorescence of the fluorods.

The fluorod is illuminated, parallel to its long axis, by ultraviolet light through a narrow slit in the holder. The length of the slit is slightly less than of the fluorod. This eliminates any variation of the fluorescent light output due to a variation in the length of the glass rods. The diameter of the rod, however, is still critical, and only fluorods with diameters between 0.98 and 1.00 mm. were used in the present study. The fluorescent light emerges through a second narrow slit, which is also parallel to the long axis of the fluorod and at a right angle to the entrance slit.

surfaces of the block are blackened to absorb stray light. The fluorod is loaded into the precision-drilled barrel of the pick with the aid of jeweler's forceps and is released from the pick by an ejector mechanism.

For calibration of the fluorimeter, a manganese glass rod (1) is permanently mounted in one fluorod holder. When this rod is placed in the fluorimeter its fluorescence produces a reading of about one hundred scale divisions. When the instrument is turned on, the reading decreases during the first few hours, after which it stabilizes. The sensitivity of the fluorimeter can be adjusted so that the

manganese glass standard reads a fixed number of scale divisions at all times.

**Precautions:** Slight chips and scratches in the glass were found to give abnormally high readings due to their reflection and refraction of the ultraviolet light.

Damage to the fluorods can be avoided by taking certain precautions. Because Lucite is softer than glass, exposed fluorods are stored in pieces of Lucite in which holes have been drilled for the purpose. The diameter of the holes is slightly larger than that of the fluorod. This storage method also serves to identify the exposed fluorods, as they are too small to be labeled individually.

The part of the pick which holds the fluorod is made of phosphor-bronze, a soft metal. Holders made of other metals scratched and damaged the glass.

Fluorods which have been exposed in a phantom or *in vivo* are always washed with soap and water and then rinsed with acetone. This precaution removes any possible surface contamination with foreign fluorescent materials. Since some glues fluoresce under ultraviolet light, they should not be used to keep the fluorod in position during exposure. The exposed fluorods are stored in a dark closet in order to avoid direct sunlight. It has been reported that exposure to sunlight for long periods will cause appreciable fading (2).

#### CHARACTERISTIC PROPERTIES OF THE FLUOROD FOR DOSIMETRY

Some of the fundamental properties of the fluorod have been studied previously (1-7), each author using a different method to measure the fluorescent light emitted and employing a different radiation source. It was decided to investigate the dosimetric properties of the fluorods in detail with supervoltage radiation (2-Mvp x-rays, h.v.l. 7 mm. Pb).

**Linearity of Response with Dose:** In order to compare the response of the fluorod with that of an ionization chamber to graded doses of 2-Mvp x-rays, both the fluorod and the ionization chamber were exposed at 1 cm. depth in a large Masonite

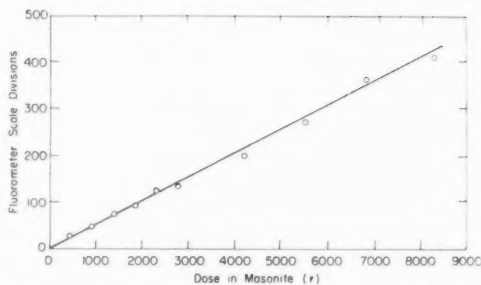


Fig. 2. Fluorod dose sensitivity. The fluorods were placed at 1 cm. depth in a large Masonite phantom and exposed to various doses of 2-Mvp x-rays. The readings obtained with the fluorimeter are drawn on the ordinate.

phantom. The response of the fluorod was found to be linear up to at least 8,000 r for high-energy x-rays (Fig. 2), though above 6,000 r a slight discoloration of the glass was observed.

**Temperature Independence:** The possibility that the response of the fluorod might vary with temperature at the time of exposure was investigated by irradiating fluorods immersed in water baths of different temperatures. The results were temperature-independent within the range under investigation (65 to 100° F.). Therefore, the fluorod can be used without temperature corrections *in vivo* or *in vitro*.

**Directionality Independence:** Since the length of the fluorod is six times the diameter, the possibility of a directionality effect was investigated. Sets of fluorods oriented at different angles to the 2-Mvp x-ray beam (20 × 20-cm. field) were irradiated simultaneously at 15 cm. depth in the Masonite phantom within 4 cm. of the central axis of the beam to insure irradiation in a homogeneous field. The measured values for the sets of fluorods at 0 to 180° with respect to the central axis of the beam, at intervals of 22.5°, were all within 2 per cent of the values for the fluorods that were placed perpendicular to the beam. Since this is within the experimental error, the fluorod response can be considered directionally independent, which is important especially for *in vivo* measurements, where the orientation of the fluorods cannot be controlled.



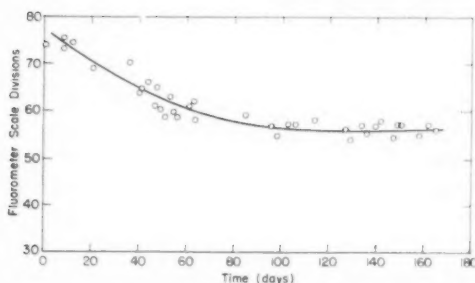


Fig. 3. Fluorod fading. Readings of the fluorescence of one exposed fluorod over a period of six months. The fading in the first few weeks is about 3 per cent per week.

**Background Fluorescence:** When fresh fluorods which have never been exposed to any radiation source are measured in the fluorimeter, a small reading is always obtained. This background reading must be subtracted from the reading obtained after irradiating each fluorod. In order to achieve 5 per cent accuracy, this reading must exceed the background by several times. With our instrument, the background reading is equivalent to approximately 80 to 100 r of 2-Mvp x-rays.

The background seen by the photomultiplier tube consists of the fluorescence of the silver ions and the light scattered within the fluorod holder. The spectral distributions of these two components differ widely. The fluorescence of the silver ions is most intense in the blue (2) and therefore is effectively absorbed by one of the secondary filters in the fluorimeter. A small fraction of the silver ion fluorescence, however, extends into the orange part of the visible spectrum. This fraction cannot be filtered out without losing a considerable amount of the light emitted from the exposed fluorod, which has its maximum intensity in the orange and red part of the visible spectrum (2). The sensitivity of the photomultiplier tube decreases rapidly in the red region and therefore the orange light is mainly used for fluorescence measurements.

The light scattered in the system of fluorod and holder covers the entire visible spectrum. Of this only a small fraction can pass the secondary filters.

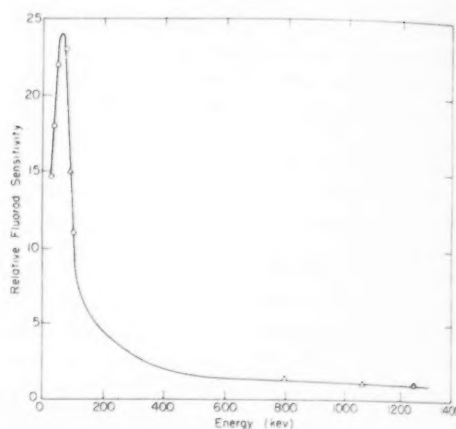


Fig. 4. Dependence of fluorod sensitivity on radiation energy. The circles represent values reported by Schulman and Etzel (3); the triangles are measurements by the authors. All values are relative to those obtained with  $\text{Co}^{60}$ .

**Salvage of Fluorods by Heat Treatment:** Since many fluorods are used in a single exposure, it was desirable to explore the possibility of their re-use. Ionizing radiation dislocates an electron within the silver-glass system. By raising the temperature of the fluorod, the electron can be returned to its original position. This is achieved by heating the exposed fluorods for five hours in a constant-temperature furnace at  $400^\circ\text{C}$ ., which reduces their fluorescence to background level. When the fluorods were kept in the furnace for shorter periods or when the temperature of the furnace was lowered, there was some residual fluorescence.

A radiation dose delivered to the recovered fluorod produces a slightly lower fluorescence reading compared with fresh rods exposed to the same dose. This reduction in sensitivity varies between a few and 10 per cent, depending on the exact time and temperature in the furnace. Therefore, only those fluorods that have been heat-treated simultaneously should be used for comparison with one another.

**Fading:** As observed by Schulman *et al.* (2) the fluorescence of the fluorod increases a few per cent within the first two to three hours after irradiation. Since the time when the maximum value is reached

can  
peri  
abou  
Then  
occu  
vari  
does  
to ra  
En  
the  
radi  
of th  
gam  
is sh  
tive  
Co<sup>60</sup>  
As t  
decr  
At a  
incre  
its  
reas  
num  
phos  
more  
tons.  
the u  
meas

TABLE

Ra  
S

200-kv  
2-Mvp  
Ra (0.  
filtra  
Co-60  
24-Mv

In  
energ  
rays  
made  
cham  
of rad  
at var  
scatte  
be di

cannot be determined accurately, our experimental readings are always made about twenty-four hours after the exposure. Thereafter a slight decrease of fluorescence occurs over many months (Fig. 3). This variation of fluorescence after exposure does not limit the application of the fluorod to radiation dosimetry problems.

**Energy Dependence:** The response of the fluorod varies with the energy of the radiation (3). The relative sensitivity of the fluorod to equal doses of x-rays or gamma rays of different effective energies is shown in Figure 4. All values are relative to the sensitivity of the fluorods to  $\text{Co}^{60}$  gamma rays, which is chosen as unity. As the effective energy of the radiation decreases, the sensitivity increases slightly. At about 200 kev, however, a sudden increase in sensitivity occurs, which reaches its maximum at about 60 kev. The reason for this is that the high atomic number elements in the silver-activated phosphate glass absorb low-energy photons more effectively than high-energy photons. A similar energy dependence affects the use of photographic film for dosimetric measurements (8, 9).

TABLE I: ENERGY DEPENDENCE OF THE FLUOROD IN PHANTOM

Radiation Source	h.v.l.	Effective Energy (kev)	Fluorod Sensitivity Relative to Sensitivity to $\text{Co}^{60}$
200-kvp x-rays	1.2 mm. Cu	88	15.1
2-Mvp x-rays	7.2 mm. Pb	800	1.2
Ra (0.5 mm. Pt filtration)	10 mm. Pb	1060	1.0
$\text{Co}^{60}$ beam	11 mm. Pb	1250	1.0
24-Mvp x-rays	13 mm. Pb	8000	1.0

In Table I, some values for fluorod energy dependence relative to  $\text{Co}^{60}$  gamma rays are given. The measurements were made by exposing fluorods and ionization chambers simultaneously to narrow beams of radiation in a large Masonite phantom at various depths. The effect of increased scattering in a wide radiation beam will be discussed below.

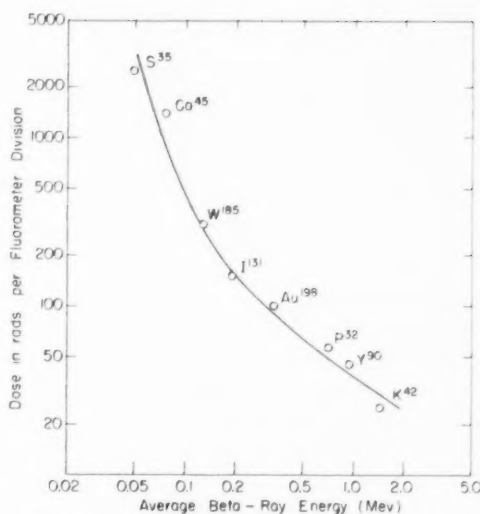


Fig. 5. Response of fluorods to beta rays from radioisotopes in aqueous solutions. The dose in rads per scale division of the fluorimeter is plotted as a function of the average energy of the beta rays.

#### Response to Beta Rays and Electrons:

The response of the fluorod to beta rays has hitherto not been measured. Two to thirty fluorods were placed in the center of each aqueous solution containing a certain beta-ray emitter. The radius of the volume of the solution was always larger than the maximum range of the beta rays. The fluorods were exposed for different times, ranging from one hour to two weeks, and then measured in the fluorimeter in units of scale divisions. The beta-ray dose delivered to the fluorod at the center of the solution was calculated from the average beta-ray energy (Table II), initial concentration, half-life of the radioisotope, and exposure time (10). The contribution of the gamma-ray dose ( $\text{I}^{131}$ ,  $\text{Au}^{198}$ ,  $\text{K}^{42}$ ) was negligible because of the small volumes of the solutions. The dose in rads per scale division for each radioisotope was then derived (Table II).

The same data are graphically presented as a function of the average beta-ray energy (Fig. 5). With decreasing energy of the beta particles, the fluorod sensitivity decreases rapidly, since the low-energy beta rays cannot penetrate deep enough into the fluorod to utilize its total volume.

TABLE II: RADIATION SENSITIVITY OF THE FLUOROD FOR VARIOUS RADIATION SOURCES

Radiation Source	Average Beta-Ray Energy (Mev)	Dose per Scale Divisions (rads)
S <sup>35</sup>	0.049	2500
Ca <sup>45</sup>	0.076	1400
W <sup>185</sup>	0.126	285
I <sup>131</sup>	0.190	150
Au <sup>198</sup>	0.331	100
P <sup>32</sup>	0.69	57
Y <sup>90</sup>	0.93	46
K <sup>42</sup>	1.45	25
24-Mev electrons	24	43
2-Mvp x-rays		24
24-Mvp x-rays		29

In addition, values of fluorod sensitivity for 24-Mev electrons, and 2- and 24-Mvp x-rays are given in Table II. These were obtained by exposing fluorods and ionization chambers in the Masonite phantom described above.

#### CLINICAL FLUOROD DOSIMETRY

The dosimetric properties of the fluorods make them ideal *in vivo* dosimeters. The doses used in daily clinical procedures (*i. e.*, 200 to 400 r) are sufficient to give readings three or four times higher than background fluorescence. This is sufficiently high for accurate reproducible readings. We have used fluorods to measure the radiation doses delivered during 2-Mvp x-ray stationary and rotation therapy and radium and Co<sup>60</sup> brachytherapy.

Previously, extensive dosimetric studies were performed in Masonite phantoms with ionization chambers and film dosimetry (11, 12), with good agreement between the two methods. Some measurements, however, could not be obtained by either of these methods because of limitations in size and difficulties of insertion into water phantoms. By using various combinations of ionization chamber, film, and fluorod dosimetry in a phantom as well as *in vivo*, a greater variety of clinical dosimetric problems can be solved.

#### High-Energy X-ray Beam Therapy

**Central Axis Depth Doses:** Since the central axis depth dose curves are fundamental for clinical radiation therapy, a set of curves for 2-Mvp x-rays measured by

ionization chamber and fluorods in a Masonite phantom is shown in Figure 6. Each point represents the average reading of three fluorods placed side by side in the phantom. For a small field, 6 × 6 cm. (Fig. 6A), there is excellent agreement between results obtained with the two dosimeters. Figure 6B shows the result for a 10 × 10-cm. field in a Masonite phantom and in a water phantom. Due to an increase of low-energy scattered radiation with increasing field size, the fluorod readings diverged toward higher values with increasing depth in the phantom. The observed difference is unimportant for practical clinical dosimetry. Even for a 15 × 10-cm. field (Fig. 6C), the difference between the ionization chamber and fluorod measurement down to a depth of about 8 cm. is within the experimental error. Below this depth, the increasing amount of low-energy scattered radiation causes a divergence of the curves. Once again this is relatively unimportant for clinical purposes, as at 20 cm. depth the difference is only 10 per cent.

When the field size is increased beyond 150 sq. cm., the discrepancy between ionization chamber and fluorod measurements becomes significant. Figure 7 shows the variation of the fluorod response with field area at the central axis of the 2-Mvp x-ray beam at 1-cm. depth in a large Masonite phantom. The increasing contribution of the scattered radiation with larger fields increases the ionization chamber measurements only by small increments. The fluorod readings, however, increase more rapidly at the large field sizes due to the enhanced sensitivity of the fluorods to the lower-energy scattered radiations. Fluorods, therefore, should not be used with very large fields. Since photographic film also has a rapidly increasing sensitivity for x-rays below 200 kev, a similar discrepancy between ionization chamber and film dosimetry is observed with increasing field size.

**Entrance Dose Measurements:** Since the skin dose is of great importance in radiation therapy, entrance dose measurements

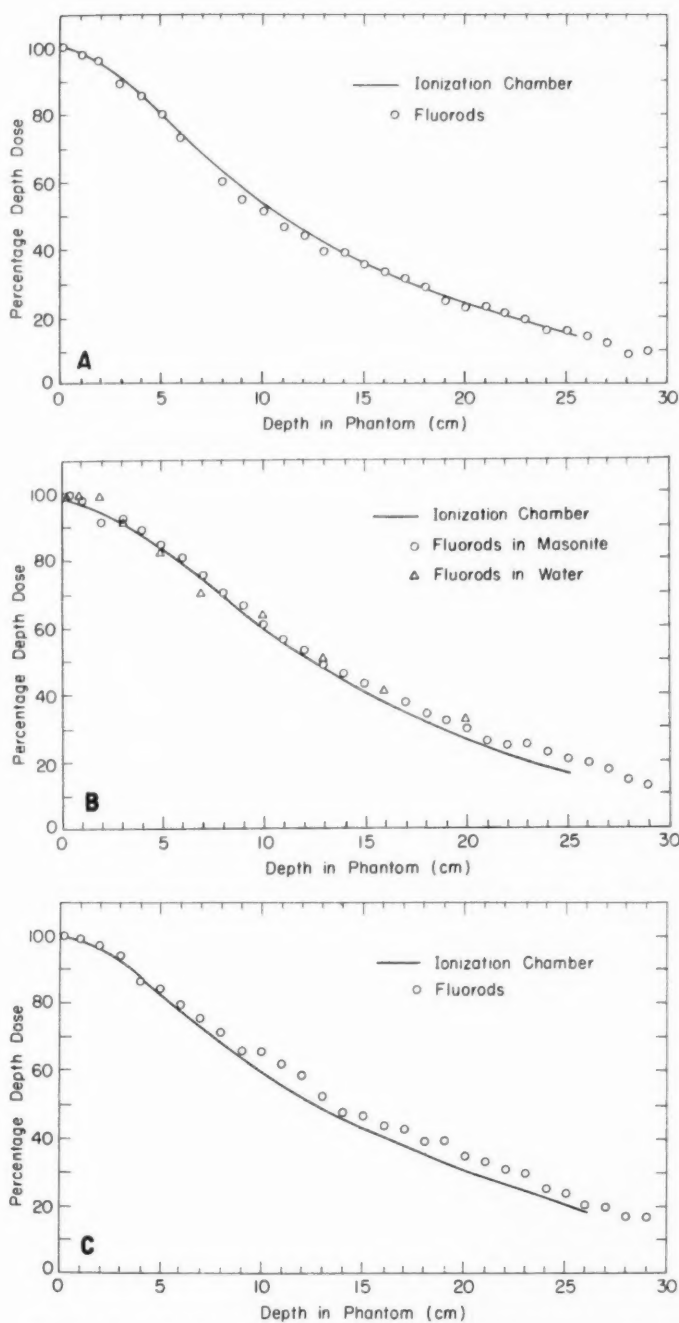


Fig. 6. Central axis depth dose measurements: 2-Mvp x-rays, 100 cm. TSD. Solid lines represent ionization chamber measurements in Masonite phantoms. A.  $6 \times 6$ -cm. portal. B.  $10 \times 10$ -cm. portal. C.  $15 \times 10$ -cm. portal. Best agreement of fluorod and ionization chamber measurements is observed with small fields.

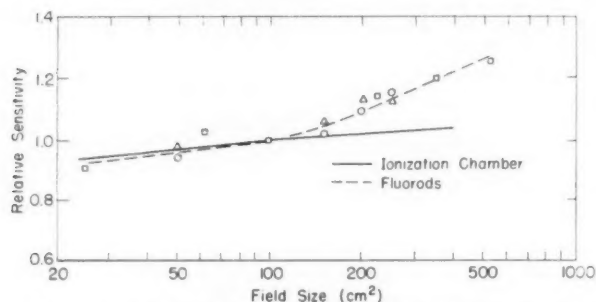


Fig. 7. Variation of fluorod response of 2-Mvp x-rays with field size. Solid line represents ionization chamber measurements; points represent fluorod measurements for different field sizes. The different symbols refer to various sets of measurements.

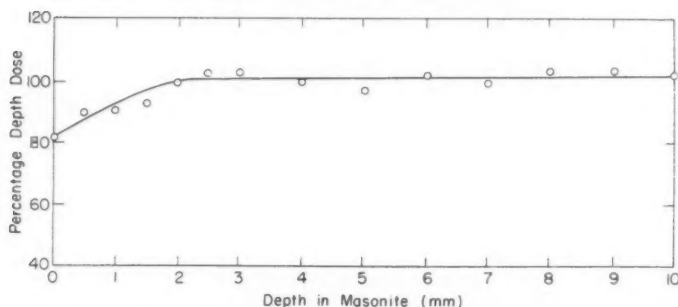


Fig. 8. Entrance dose in Masonite. Sets of fluorods at different depths in a Masonite phantom were exposed to 2-Mvp x-rays, at 100 cm. TSD,  $10 \times 10$ -cm. field.

under treatment conditions were investigated with fluorods. It must be realized that, if the fluorod is placed with its long axis perpendicular to the x-ray beam on the surface of a phantom or on the skin of a patient, the measured dose will be an average value for a depth somewhat less than the diameter of the fluorod (1 mm.). Therefore the fluorod entrance dose measurements cannot be compared directly with extrapolation ionization chamber measurements, as recently reported by Baily and Beyer (13).

The build-up of dose within the first 10 mm. of absorber was studied by placing fluorods on the surface of a Masonite phantom and in 1-mm. diameter holes at successive 0.5-mm. depths. Forty-two fluorods, 3 at each depth, all within 1 cm. of the central axis of the beam, were exposed simultaneously. The readings of the bare fluorods on top of the Masonite phantom had a value of 83 per cent of the maximum

value at a depth of about 3 mm. below the surface of the phantom (Fig. 8). The depth of the maximum value is in agreement with that obtained with ionization chamber measurements (13).

The dose on the surface of the skin was measured on a number of patients by taping fluorods to the skin in the center of the treatment portal. When the observed value was compared with the calculated maximum skin dose, an average value of  $84 \pm 4$  per cent was obtained. The field sizes used for patient measurements ranged from  $6 \times 8$  to  $10 \times 15$  cm. A slight increase of the fluorod readings with increasing field size was again noticed. Good agreement was found between fluorod measurements on the skin and on the surface of the Masonite phantom.

**Exit Dose Measurements:** Exit dose measurements were made by placing additional fluorods on patients under treatment with 2-Mvp x-rays. In order to



obtain high enough readings with the fluorods positioned in the exit beam, the thickness of the absorbing tissue had to be less than 15 cm. Head and neck cases were therefore used for this study. All measurements were made with the patient sitting to avoid back-scatter from the floor or supporting material.

Exit dose measurements for 2-Mvp x-rays for various field sizes in Masonite phantoms have been made recently by Baily and Beyer (14) with an extrapolation ionization chamber. Figure 9 shows

build-up of scattered radiation in the infinite phantom.

*Dose Distribution with Tangential Beams:* For a number of clinical applications, the x-ray beam strikes the skin at a shallow angle instead of being incident perpendicular to the surface—so-called tangential beam irradiation. Under such conditions it is difficult to evaluate the dose distribution from standard depth dose data.

The treatment of the lymph nodes in both sides of the neck without injury to the spine, larynx, or pharynx is one ex-

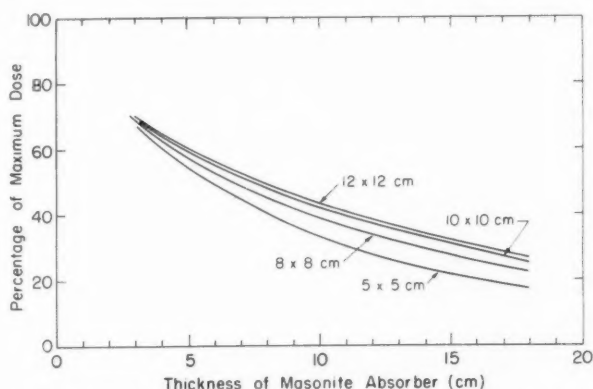


Fig. 9. Exit doses for 2-Mvp x-ray beams as a function of the absorber thickness. Values are taken from extrapolation chamber measurements made by Baily and Beyer (14).

their results, which were reported in tabular form. The values of the exit doses for various absorber thicknesses are given as per cent of the maximum surface dose at a few millimeters depth.

Fluorod patient measurements and ionization chamber phantom measurements are shown in Table III. Although one method is applied to phantom studies and the other to patient studies, the results of the two sets of measurements are in good agreement. The values given in Table III for the ionization chamber measurements were taken from Figure 9. The percentage depth dose at the "exit depth," as measured in an infinite phantom, is considerably higher (approximately 50 per cent) than the measured exit doses (Table III). This difference is surprisingly large and may be explained by

TABLE III: EXIT DOSE MEASUREMENTS

Field Size (cm.)	Absorber Thickness (cm.)	Central Axis Depth Dose in Infinite Phantom (per cent)	Fluorod Exit Dose Measurements in Patients (per cent)	Extrapolation Chamber Exit Dose Measurements in Phantom* (per cent)
7 × 8	13	43	29	30
8 × 10	10	56	39	40
6 × 10	13	43	32	29
9 × 13	14	45	29	33

\* Taken from reference 14.

ample of tangential beam irradiation. A lead block, 4 cm. wide and 4 cm. thick, is placed in front and in back of the neck depending on the direction of incidence of the beam. The patient is treated alternately in each position. The resulting

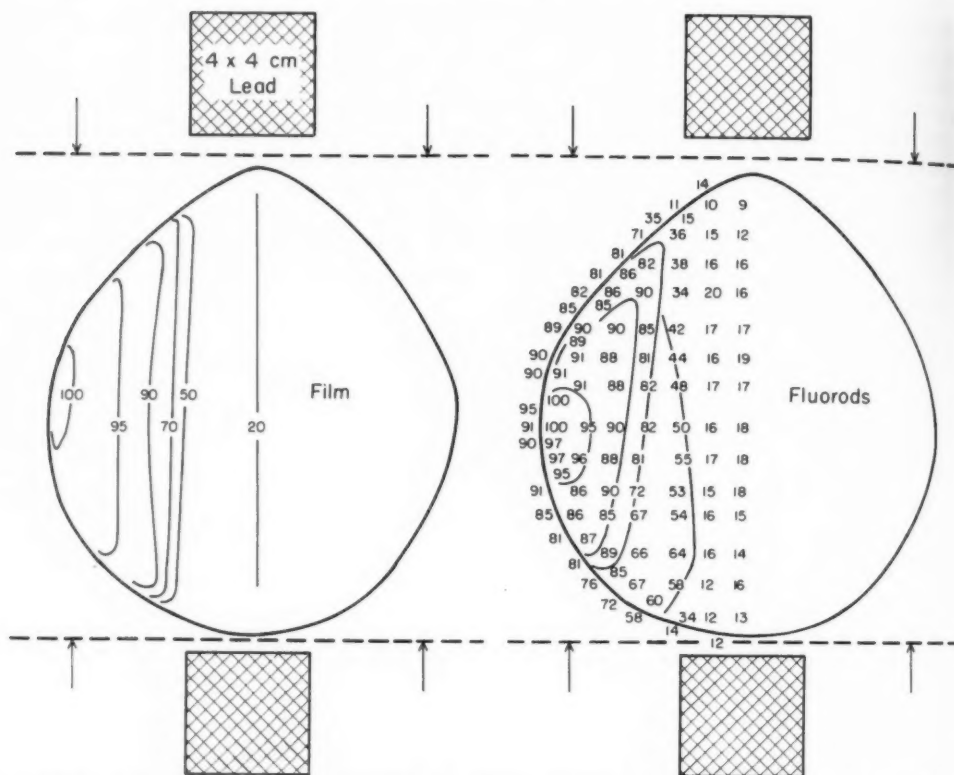


Fig. 10. Dose distributions for treatment of lymph nodes in the neck with minimal doses to spine, larynx, and pharynx. The neck phantom was irradiated front and back with 2-Mvp x-rays,  $15 \times 10$ -cm. field with a  $4 \times 4$ -cm. lead block in the center of the field. On the left, isodose curves obtained by film dosimetry are shown; on the right fluorod dose measurements.

dose distribution is shown in Figure 10. The isodose curves on the left were obtained by film dosimetry. The relative dose values on the right were obtained with fluorods. The fluorods on the periphery were half imbedded in the Masonite phantom (Fig. 11). The results by the two methods are in good agreement. In the area blocked out by the lead absorber a value of 10 to 20 per cent of the maximum dose is observed. Only a small fraction of that is due to primary radiation, whereas most is caused by scattered radiation. Since both film and fluorods have an elevated sensitivity for lower-energy scattered radiation, both values might be somewhat high. The areas of high radiation intensity (90 per cent isodose line) are symmetrically positioned and are of simi-

lar shape for both sets of measurements.

**Dose Distribution in Rotation Therapy:** The dose at the center of rotation is calculated with the aid of tumor-air ratios. By using fluorods it has been possible for the first time to check the accuracy of this procedure.

Two examples are presented: a bladder and a nasopharynx, irradiated with 2-Mvp x-rays,  $360^\circ$  rotation, at 125 cm. target-axis distance. For the bladder the diameter of the field at the center of rotation was 8 cm. A Foley balloon was inserted into the bladder and inflated with water to 5 cm. diameter. Three fluorods in Teflon tubing were fixed in the center of the balloon. The calculated tumor dose was 260 r. and the dose measured by the fluorods was 246 r. In this, and in other

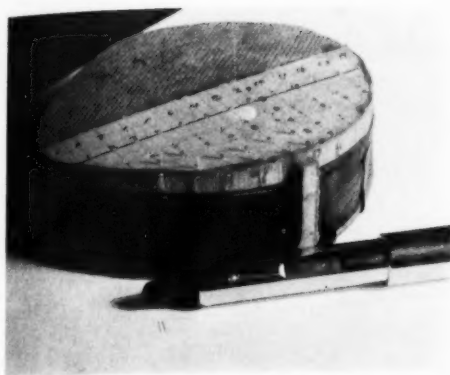


Fig. 11. Neck phantom used for dosimetric studies with tangential irradiation technique. Note the fluorods fastened to the skin surface position, and dispersed at 1-cm. intervals throughout the neck volume. An ionization chamber is shown for comparison of sizes.

similar cases, dose measurements agreed with the calculated dose within the limits of accuracy of the two methods.

For the nasopharynx the diameter of the field at the center of rotation was 5 cm. Seven fluorods in Teflon tubing were aligned in tandem on a wood applicator stick with the centers of the fluorods spaced 1.5 cm. apart. The applicator was inserted into the left nostril with the proximal fluorod touching the tumor and lying 0.5 cm. from its center. The calculated central tumor dose was 340 r; the dose measured with the proximal fluorods was 284 r. The distribution along the applicator, expressed in per cent of the maximum tumor dose, is presented in Table IV.

TABLE IV: TUMOR IN NASOPHARYNX  
125 cm. target-axis distance;  $5 \times 7$ -cm. port;  $360^\circ$  rotation. Calculated tumor dose, 340 r. Measured dose (fluorods), 284 r

Distance from Center of Tumor (cm.)	Fluorod in Patient (per cent)	Film in Phantom (per cent)
0.5	100	100
1.5	86	95
3.0	76	70
4.5	42	50
6.0	30	40
7.5	8	30
9.0	0	-

The third column in the table shows values obtained by film dosimetry in a Masonite phantom. In a situation as

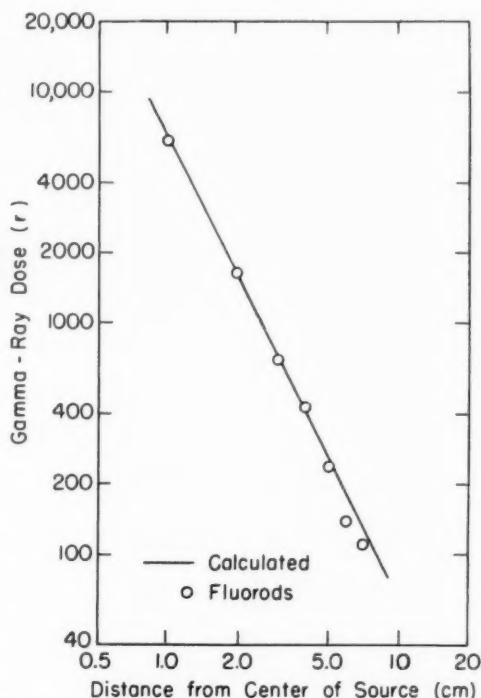


Fig. 12. Fluorod measurements of dose distribution of a  $\text{Co}^{60}$  pellet, 3 mm. in diameter. The straight line represents the inverse-square law on the log-log scale.

complex as that presented by a nasopharyngeal tumor, it is likely that the fluorod measurements within the patient are more reliable than the calculated values or those obtained by film dosimetry in a homogeneous phantom.

#### *$\text{Co}^{60}$ Brachytherapy*

Accurate dose measurements close to  $\text{Co}^{60}$  and radium sources and applicators have been difficult to obtain. These measurements can now be made with fluorods, as these are small enough to be positioned very close to the source and their dose response is independent of the gamma-ray energy for all high-energy gamma-ray emitters.

*Measurements Close to Spherical  $\text{Co}^{60}$  Sources:* A 3-mm. diameter  $\text{Co}^{60}$  pellet was partially imbedded in Masonite. Fourteen fluorods were placed in radial arrangement 1 cm. apart up to a distance of 7 cm. from the center of the source, in

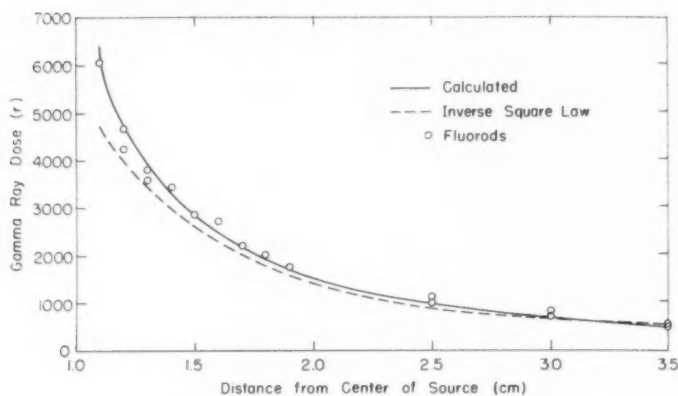


Fig. 13. Fluorod measurements of a  $\text{Co}^{60}$  pellet of 20 mm. diameter. The broken line represents the inverse-square-law fall-off from a point source. The solid line represents the dose calculated for an extended source. The points are the fluorod measurements.

small holes in the Masonite. The entire system was immersed in water. Figure 12 shows the average fluorod measurement as a function of distance from the source. The observed data plotted on a log-log scale follow the straight line representing the inverse-square law.

The results for a large  $\text{Co}^{60}$  pellet, 20 mm. in diameter, are shown in Figure 13. Good agreement was observed between fluorod measurements and the values calculated from Mayneord's formula, even at a distance of 1 mm. from the surface of the pellet. At such a short distance from the surface of an extended source, the dose distribution is not expected to follow the inverse-square law.

**$\text{Co}^{60}$  Applicator:** An example of a  $\text{Co}^{60}$  intra-oral applicator is shown in Figure 14. Nine spherical pellets, 0.5 cm. in diameter, containing 7.4 millicuries  $\text{Co}^{60}$  each, were placed in holes along a concave surface of the mold. Their centers were 7 mm. below the surface. The dose rate was calculated by adding the contributions of the nine pellets, using the inverse square law with the distances measured from the center of each pellet to the points of interest on the surface of the mold. The calculated dose rate at the center of the surface of the mold was 566 r/hr. The fluorods registered a dose rate of 520 r/hr. The fluorods re-

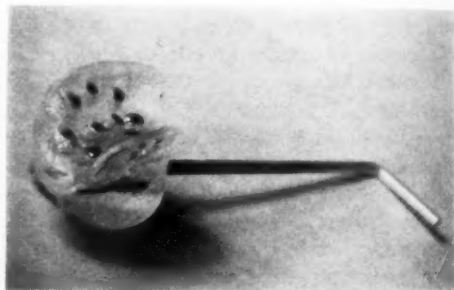


Fig. 14. Intraoral brachytherapy applicator. Nine  $\text{Co}^{60}$  pellets are distributed in a concave plane for the treatment of a squamous-cell carcinoma of the superior alveolar ridge.

vealed some unevenness in dose rate along the tumor mold interface (Fig. 15). Fluorods placed on the sides of the applicator, which were in contact with the buccal mucosa and tongue, disclosed a hot spot on the buccal surface.

#### SUMMARY

The fluorod (a silver-activated phosphate glass rod) is a tiny dosimeter whose fluorescence following ionizing irradiation is proportional to the dose. Its potential usefulness in clinical radiation therapy, due to its small size ( $1 \times 6$  mm.), prompted a physical and clinical investigation of its dosimetric properties.

Following exposure to radiation, the fluorod is positioned in a fluorimeter and

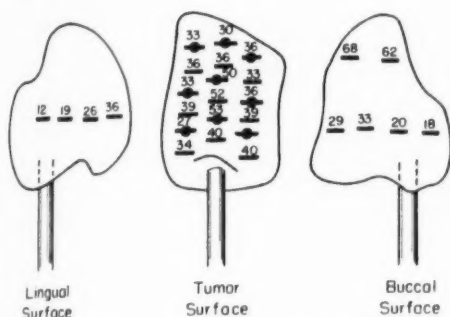


Fig. 15. Dose rate distribution on three surfaces of the intraoral  $\text{Co}^{60}$  applicator shown in Fig. 14. Multiply the given numbers by 10 to obtain dose rate in r/hr. as measured by the fluorods. Note the two hot spots on the buccal surface. These produced a severe reaction on the buccal mucosa.

its fluorescence under ultraviolet light is measured. The fluorod has the following dosimetric properties when exposed to 2-Mvp x-rays; the response is linear to dose up to at least 8,000 r; it is independent of temperature at the time of exposure; it is independent of the direction of the incident beam of radiation in a scattering material; the fluorescence fades very slowly over a period of many months; the background fluorescence is approximately 80 to 100 r, making the fluorod useful for experimental or clinical doses above 200 r; heat treatment for approximately five hours at  $400^\circ\text{C}$ . reduces the dose effect to background level so that the fluorod can be used again.

Because of energy dependence, fluorods should be used only for energies higher than 400-kvp x-rays. They are particularly useful for supervoltage x-rays and radium and  $\text{Co}^{60}$  gamma-ray dose measurements.

The dose responses to radioisotope beta rays in solution and high-energy betatron electron beams were determined.

Pilot dosimetry in phantoms and patients showed potential clinical usefulness of the fluorod. Problems such as tangential beam dosimetry, measurements of

tumor dosage in body cavities, and dose measurements close to  $\text{Co}^{60}$  topical applicators were studied in particular.

NOTE: Acknowledgment is expressed to William H. Ellett for his assistance in the early phases of this work, and to the Radiotherapy Center, the Mt. Sinai Hospital, New York, for the use of their Betatron and  $\text{Ca}^{60}$  Teletherapy unit.

Radiation Therapy Department  
Hospital for Joint Diseases  
New York 35, N.Y.

#### REFERENCES

- SCHULMAN, J. H., SHURCLIFF, W., GINTHER, R., AND ATTIX, F.: Radiophotoluminescence Dosimetry System of the U. S. Navy. *Nucleonics* 11: 52-56, October 1953.
- SCHULMAN, J. H., GINTHER, R. J., AND KLINK, C. C.: Report of NRL Progress (NRL Reprint 65-52), July 1952.
- SCHULMAN, J. H., AND ETZEL, H. W.: Small-Volume Dosimeter for X-rays and Gamma-rays. *Science* 118: 184-186, Aug. 14, 1953.
- SCHULMAN, J. H., GINTHER, R. J., AND KLINK, C. C.: Dosimetry of X-rays and Gamma-Rays by Radiophotoluminescence. *J. Appl. Physics* 22: 1479-1487, December 1951.
- ETZEL, H. W., KIRK, R. D., AND SCHULMAN, J. H.: Small Volume Dosimeter. *RA-DET* 8: 49-56, July 1955.
- RIEGERT, A. L., JOHNS, H. E., AND SPINKS, J. W. T.: Ag-Phosphate Glass Needles for Measuring Gamma Dose. *Nucleonics* 14: 134-137, November 1956.
- DEGELMAN, J., CALLAHAN, A. B., AND FULTON, G. P.: An Improved Fluorometer for Miniature Glass Rod Radiation Detectors. *Radiation Res.* 6: 548-553, May 1957.
- HINE, G. J.: The Range of Usefulness of Photographic Film in Roentgen Dosimetry. *Am. J. Roentgenol.* 72: 293-301, August 1954.
- GRANKE, R. C., WRIGHT, K. A., EVANS, W. W., NELSON, J. E., AND TRUMP, J. G.: The Film Method of Tissue Dose Studies with 2.0 Mev Roentgen Rays. *Am. J. Roentgenol.* 72: 302-307, August 1954.
- LOEVINGER, R., HOLT, J. G., AND HINE, G. J.: Internally Administered Radioisotopes. [In] *Radiation Dosimetry*, edited by G. J. Hine and G. L. Brownell. New York, Academic Press, 1956.
- FRIEDMAN, M., HINE, G. J., AND DRESNER, J.: Principles of Supervoltage (2 Million Volts) Rotation Therapy. *Radiology* 64: 1-16, January 1955.
- FRIEDMAN, M., DRESNER, J., AND HINE, G. J.: Supervoltage (2,000 Kilovolt Roentgen Rays) Irradiation with a Resonant Transformer Generator. *Am. J. Roentgenol.* 73: 410-424, March 1955.
- BAILY, N. A., AND BEYER, N. S.: Surface and Entrance Dose for a 2-Mvp X-Ray Beam. *Radiology* 69: 553-557, October 1957.
- BAILY, N. A., AND BEYER, N. S.: Exit Dosage for 2-Mvp X-Rays. *Radiology* 70: 395-397, March 1958.

(Pro le summario in interlingua, vider le pagina sequente)



## SUMMARIO IN INTERLINGUA

## Le Dosimetria de Radiation con le Fluorod (Dosimetria a Virgula de Vitro in Miniatura)

Le Fluorod (un virgula de vitro a argento e phosphato activate) es un micrisime dosimetro que reage a irradiation ionisante per un fluorescentia proportional al dose applicate a illo. Su utilitate potential in le practica del therapia radiational—su grande advantage es su micre dimensiones ( $1 \times 6$  mm)—ha stimulate le hic-reportate investigation physic e clinic de su proprietates dosimetric.

Post exposition a radiation, le Fluorod es placiante in un fluorimetro, e su fluorescentia es mesurate in lumine ultraviolette. Le Fluorod ha le sequente proprietates dosimetric quando illo es exponite a radios Roentgen de 2 Mvp: Le responsa es linear con respecto al dose usque a al minus 8,000 r; illo non depende del temperatura al tempore del exposition; illo non depende del direction del incidente fasce de radiation in un materia dispersori; le fluorescentia evanesce lentissimamente in le curso de multe menses; su fluorescentia inherente es approximativemente 80 a 100 r, de maniera que illo es utile in le

labor con doses experimental o clinic de plus que 200 r; calefaction a 400 C durante approximativemente cinque horas reduce le effecto al nivello del fluorescentia inherente de maniera que le Fluorod pote esser re-usate.

A causa de su dependentia del energia, le Fluorod deberea esser usate solmente con radios X de plus que 400 kvp. Illo es specialmente utile pro labores con radios X de supervoltage e pro mesurationes del dose de radios gamma ab radium e  $\text{Co}^{60}$ .

Esseva determinate le responsas a doses de radios beta radioisotopic in solution e de fasces de electrones de un betatron a alte energia.

Studios de probation in phantomas e in pacientes demonstrava le utilitate clinic potential del Fluorod. Esseva investigate particularmente problemas del typo de dosimetria a fasce tangential, mesurationes del dosage al tumor in cavitates del corpore, e le mesuration del dose proxime a applicatores topic de  $\text{Co}^{60}$ .



## Segmental Colitis<sup>1</sup>

RICHARD H. MARSHAK, M.D., BERNARD S. WOLF, M.D., and JOAN ELIASOPH, M.D.

THE PURPOSE of this paper is to demonstrate the roentgen features of chronic colitis involving limited portions of the colon. Numerous terms have been used to describe this condition, namely, right-sided ulcerative colitis, regional colitis, Crohn's disease of the colon, segmental colitis. When there is simultaneous involvement of the small bowel, enterocolitis and ileocolitis have been included. Of these various terms, "segmental colitis" has become the most popular.

We define segmental colitis as a chronic, non-specific inflammatory process involving a limited portion of the colon. The pathologists at this hospital (Mount Sinai, New York) have reported these cases as ulcerative, resembling universal ulcerative colitis, or granulomatous, akin to regional enteritis. At the present time, we do not consider segmental colitis as a separate disease entity.

One hundred and forty-six cases of limited colitis have been studied, exclusive of isolated involvement of the rectum and sigmoid. This report represents a preliminary attempt to distinguish, on a roentgen basis, segmental ulcerative colitis from segmental granulomatous colitis. It should be noted that in many instances this differentiation is impossible. The effort to distinguish the two would appear, however, to be of practical usefulness because of the variations in clinical behavior, prognosis, and treatment.

### HISTORY

Diffuse ulcerative colitis was described in 1880 in a textbook of pathology by Wilks and Moxon (1) and there have been a tremendous number of articles on this topic since that time. On the subject of limited colitis, the literature is relatively scanty. From 1890 to 1930, only scattered case

reports of localized inflammatory disease of the colon appeared. The hyperplastic or granulomatous nature of the lesion was emphasized, as well as its resemblance to carcinoma and to tuberculosis.

In 1930 Bargaen and Weber (2) described a group of these cases, emphasizing the lack of involvement of the rectum and sigmoid. To this entity they applied the term "regional migratory chronic ulcerative colitis." As in diffuse ulcerative colitis, it was noted that a short segment of terminal ileum in continuity with the diseased colon could be involved by "backwash ileitis."

In 1938 Crohn and Berg (3) reported a similar group of cases under the name of "right-sided regional colitis." These investigators preferred to stress the localization in the right side of the colon. They considered the process, however, to be a form of diffuse ulcerative colitis.

Neuman and Dockerty (4) in 1954 described the pathologic alterations, employing the term "regional colitis," and noted involvement of the distal ileum in 25 per cent of their cases. They reported thickening of the colonic wall and non-specific granuloma formation on microscopic examination. Their observations differed from the descriptions of the gross and microscopic features of ulcerative colitis given by Warren and Sommers (5), who stated that ulcerative colitis restricted to the right side is rare. Rappaport, Burgoyne, and Smetana (6) objected to the term "regional colitis" because of its similarity to the term "regional enteritis." They held that limited colitis resembles ulcerative colitis rather than regional enteritis in its pathology.

In a recent paper, Bargaen (7) defines regional segmental colitis as "inflammatory disease of the large intestine of unknown

<sup>1</sup> From the Department of Radiology, The Mount Sinai Hospital, New York, N. Y. Presented at the Forty-fourth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 16-21, 1958.

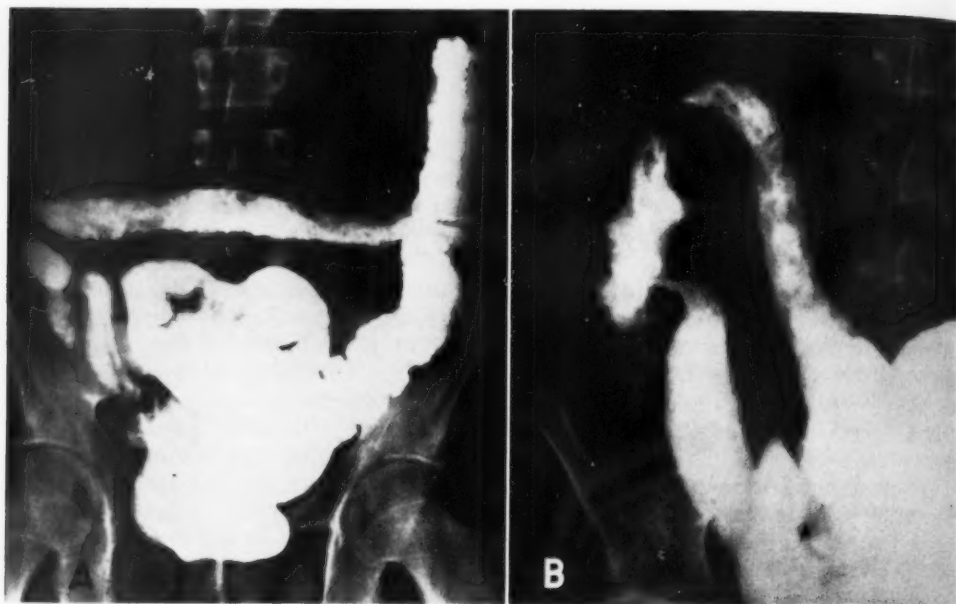


Fig. 1. A. Typical ulcerative colitis extending from cecum to ascending colon with symmetrical uniform involvement of the bowel and shortening of the right colon. The ileum is similarly involved—"backwash ileitis." This localization of the disease is often termed "right-sided ulcerative colitis."

B. The appearance is similar to that seen in Figure 1, A. Small inflammatory polyps are also visualized.

cause. It is both granulomatous and ulcerative in character with a tendency to spread. The nature of this condition leads to the possibility that when the solution of its origin is at hand, the disease may well be one with several lesions of different causes."

#### SEGMENTAL ULCERATIVE COLITIS

Ulcerative disease of limited extent most commonly involves the rectum, but when that organ is spared, it is most frequently located in the right colon, extending distally for a variable distance, often to the splenic flexure and sigmoid (Fig. 1, A). The least common variety is ulcerative colitis, which spares both the rectum and the right side of the colon (Fig. 2). Ileal involvement in continuity with the colonic lesion, so-called "backwash ileitis," is frequent.

The roentgen findings in the colon are essentially similar to those of universal ulcerative colitis and vary from minimal to severe. In minimal cases, spasm and irritability associated with abnormalities in

the appearance of the haustral markings, manifested by widening, distortion, and irregular spacing, as well as minute ulcerations of the mucosa, are clues to the presence of the underlying pathologic change. In other cases, the many intervening stages between minimal and maximal severity are seen, with mucosal ulcerations, distorted or absent haustrations, increasing rigidity and narrowing of the lumen, and finally longitudinal shortening due to fibrosis. Contraction in the length of the bowel is a conspicuous feature and is most marked in the ascending colon and cecum (Fig. 1, A). The involvement is usually symmetrical. Small inflammatory polyps were observed in about a fifth of the cases (Fig. 1, B). Sinus tracts arising from the cecum and ascending colon were noted 4 times, and in 2 cases there were fistulas from the transverse colon to the third portion of the duodenum. This is a surprising feature, as fistulas to other portions of the intestinal tract in diffuse ulcerative colitis have been rare in our experience. Skip lesions, with

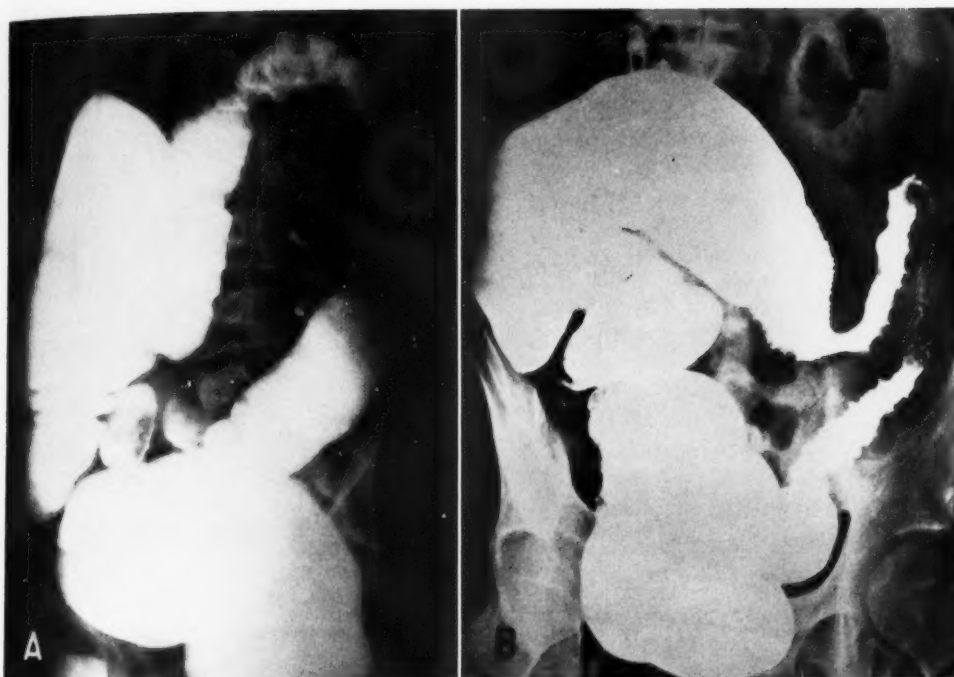


Fig. 2. A. An unusually limited localization of ulcerative colitis. The right colon, sigmoid, and rectum are spared. This may truly be called segmental ulcerative colitis.

B. Three years later, there is narrowing of the bowel lumen but no increase in the extent of the disease. Resection showed ulcerative colitis.

uninvolved bowel of significant length between them, were uncommon. The termination of the lesion could be recognized in most instances.

In burned-out ulcerative colitis, marked narrowing of the bowel can occur. These strictures are characteristically smooth, tapering, and fairly short. Their differentiation from carcinoma is important.

In those patients in whom involvement of the ileum was observed, the ileal lesion was in continuity with the colonic lesion and was present at the time of the initial roentgen study. The section of ileum affected is usually short and the involvement is limited to mucosal alterations, the so-called "backwash ileitis" as seen in universal ulcerative colitis (Fig. 1). Marked spasm and limitation of distensibility may occur, and differentiation from regional enteritis can be difficult. In 6 patients, there was no question that the changes in

the terminal ileum were due to regional enteritis, while the colonic involvement was segmental ulcerative colitis. It is of interest that in these patients, too, regional enteritis was usually seen in continuity with the inflammatory disease of the colon.

Extension of the ulcerative process in the colon (Fig. 2) was rare; it was observed in 2 patients during the course of an acute fulminating episode. It is surprising that over a period of years most of these cases showed no remarkable change in the extent of the lesion.

In one patient, huge dilatation of the colon supervened during an acute fulminating episode. Marked enlargement of the colon, especially in its transverse portion, in a patient with ulcerative colitis has been of ominous prognostic significance and in our cases frequently indicated an impending perforation.

The pathologic alterations noted on gross

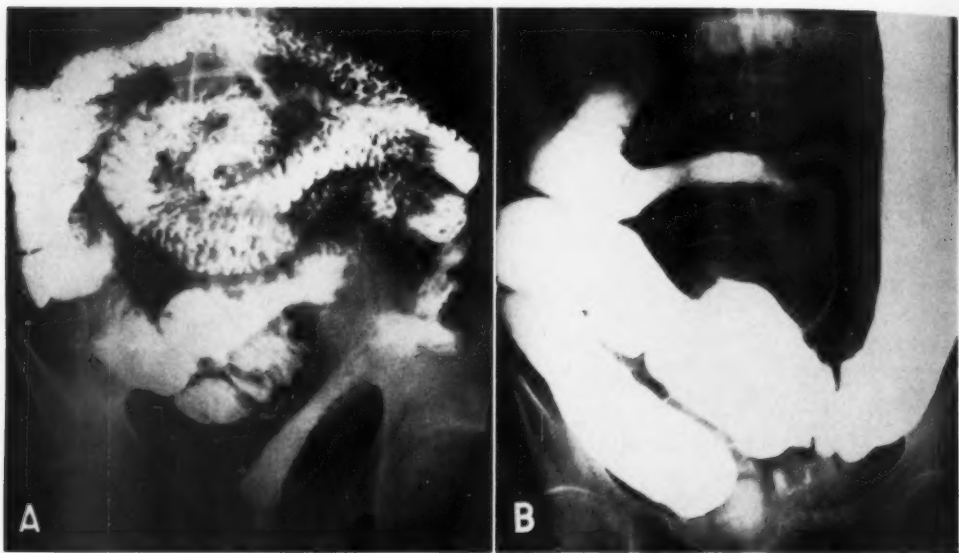


Fig. 3. A. Ileosigmoidostomy for right-sided ulcerative colitis with "backwash ileitis." There is extension of the inflammatory process into the remaining sigmoid and rectum.

B. Regional enteritis following ileosigmoidostomy for segmental granulomatous colitis. There are narrowing and rigidity of a long segment of ileum immediately proximal to the anastomosis, associated with multiple small inflammatory polyps.

and microscopic examination were similar to those described in diffuse ulcerative colitis except for the segmental distribution. The bowel was most often of normal thickness. In 2 cases it was thin and in 4 it was somewhat thicker than is usually identified. Inflammatory polyps were small and skip lesions of any extent were noted twice. On microscopic examination the inflammatory process was exudative and ulcerative, and granulomata were infrequently noted. The findings in the ileum simulated the colonic alterations but were of lesser severity.

In general, the disease was characterized by fever, diarrhea, and cramps. Systemic manifestations such as arthritis, erythema nodosum, and ocular complications were slightly more common than is usual in regional enteritis or diffuse ulcerative colitis.<sup>2</sup>

The operation most frequently performed in this series of cases was ileosigmoidos-

tomy with resection of the diseased portion of the colon. Following surgery, the frequency of extension of the ulcerative disease into the rectum and sigmoid was approximately 40 per cent (Fig. 3, A). In many of these cases, a subsequent ileostomy was required, with resection of the sigmoid and rectum. Extension of the disease into the small bowel with granulomatous involvement was noted in 3 instances after ileosigmoidostomy.

#### SEGMENTAL GRANULOMATOUS COLITIS

Granulomatous disease of limited extent least commonly affects the rectum. The segments most frequently involved are the transverse colon or the cecum and ascending colon, often in association with regional enteritis, either in the form of a skip lesion or in continuity. The roentgen alterations in most of these cases were well established at the time of the initial study (Fig. 4, A). In general, a lesser length of colon was affected than in segmental ulcerative colitis. In 3 cases the sigmoid and rectum were involved (Fig. 4, B). Involvement of

<sup>2</sup> Extension of the inflammatory process in the absence of operation, either in the form of a skip lesion or in continuity, was seen only once.



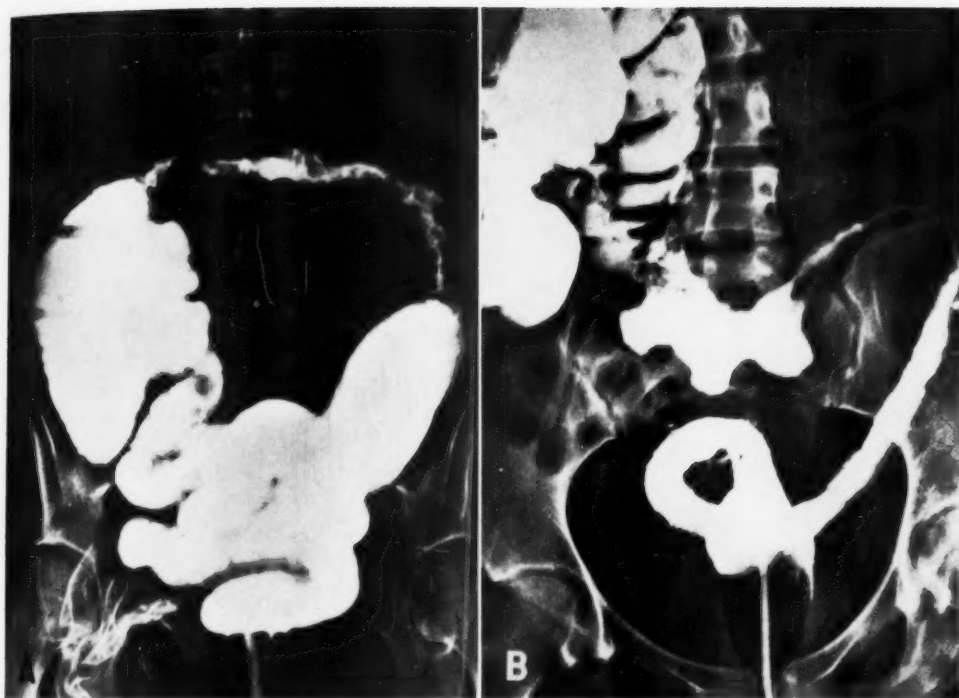


Fig. 4. A. Segmental granulomatous involvement of the transverse colon, characterized by narrowing of the lumen, shortening of the bowel, sharp demarcation of the lesion, and coarse irregularity of the contours. The terminal ileum and right colon are dilated.

B. Segmental granulomatous colitis involving the left colon and rectum, characterized by marked luminal narrowing, linear ulcerations, and numerous sinus tracts extending perpendicular to the bowel wall. Pseudodiverticula with eccentric involvement of the bowel are present in the mid-transverse colon.

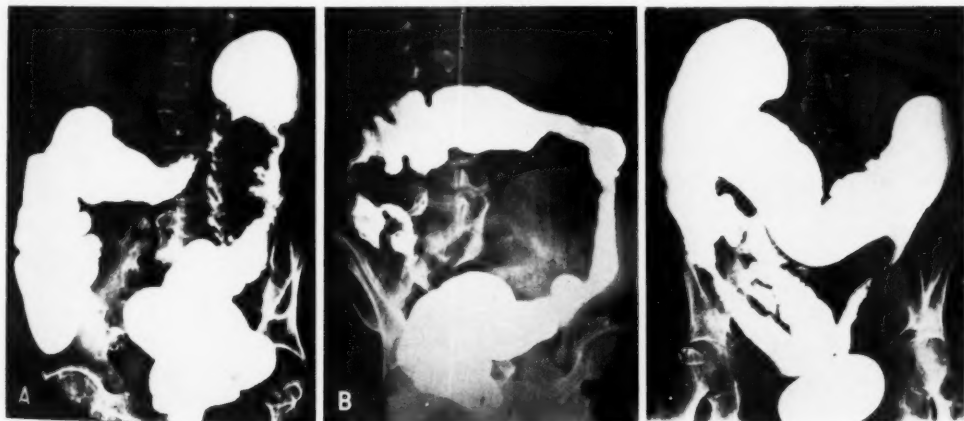


Fig. 5. A. A normal colon intervenes between two segments involved by segmental granulomatous colitis in the transverse and descending colon. These are often called "skip lesions."

B. Cecum, ascending colon, distal transverse colon, and a portion of the descending colon involved by segmental granulomatous colitis in association with regional ileitis.

C. Regional ileitis and segmental granulomatous colitis involving the descending colon occur together. Subsequently a sinus tract to the skin arose from the descending colon.

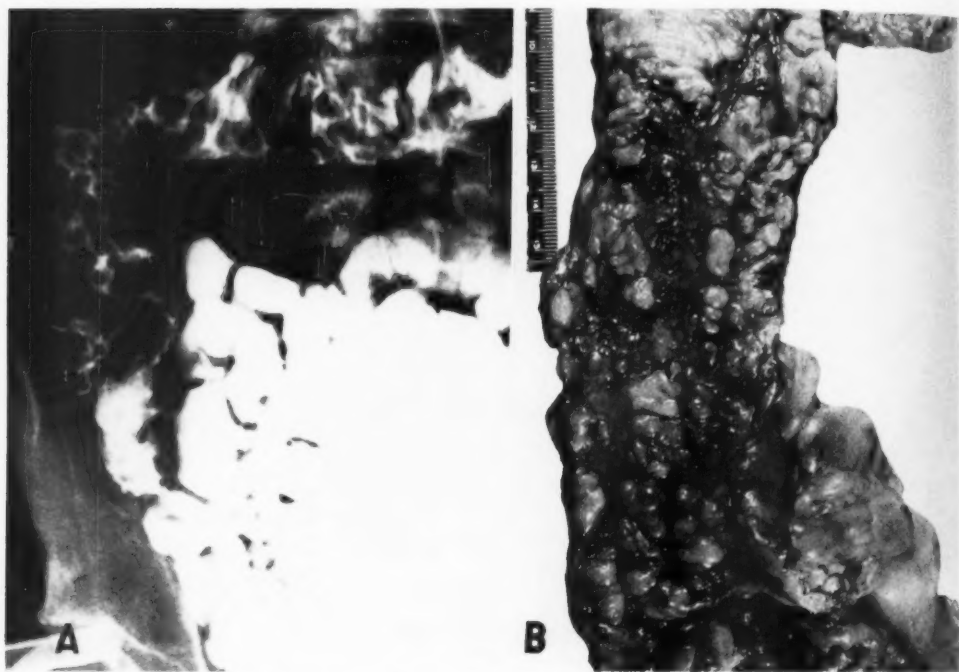


Fig. 6. A. Granulomatous ileocolitis. There is simultaneous and similar involvement of the terminal ileum and right side of the colon in continuity. Large inflammatory polyps, linear ulcerations, and coarse irregularity of the contours are present.

B. Specimen showing the large inflammatory polyps, enlarged lymph nodes, thickening of the bowel wall, and linear ulcerations. Microscopically numerous granulomas were noted.

these segments by granulomatous disease has rarely been reported. The termination of the lesion was usually sharply demarcated, and skip lesions were not uncommon (Figs. 5, A and B). Inflammatory polyps were larger, and on occasion characteristic linear ulcerations could be identified. The contours of the bowel lumen were frequently coarsely irregular (Fig. 4, A). Eccentric involvement of the wall was common in contrast to the symmetrical involvement in segmental ulcerative colitis (Fig. 4, B). Contraction of the length of bowel was not as marked as in ulcerative colitis. Smooth, tapering strictures such as are identified in burned-out ulcerative colitis were rare. Fistulas were noted 4 times, twice to the duodenum and twice to the stomach. Sinus tracts were not unusual.

In 4 cases there were marked spasm and irritability of the terminal ileum and right side of the colon. The folds were coarsely

thickened and the contours irregular, with areas suggestive of large ulcerations. The ileum had an appearance strikingly similar to the colonic process (Figs. 6 and 7). Fistulas or evidence of thickening of the mesentery were not observed. In the absence of these common secondary findings of regional enteritis, the possibility that this form of ileocolitis represents an entirely different disease entity, as postulated by some, must remain open. When operation was performed in these cases, the marked thickening of the submucosa usually associated with regional enteritis was not identified. However, on microscopic examination, numerous granulomas were seen and the mucosal ulcerations were characteristically linear and deep.

Pathologically, in granulomatous colitis in contradistinction to segmental ulcerative colitis, the bowel wall was thickened and the inflammatory changes in most

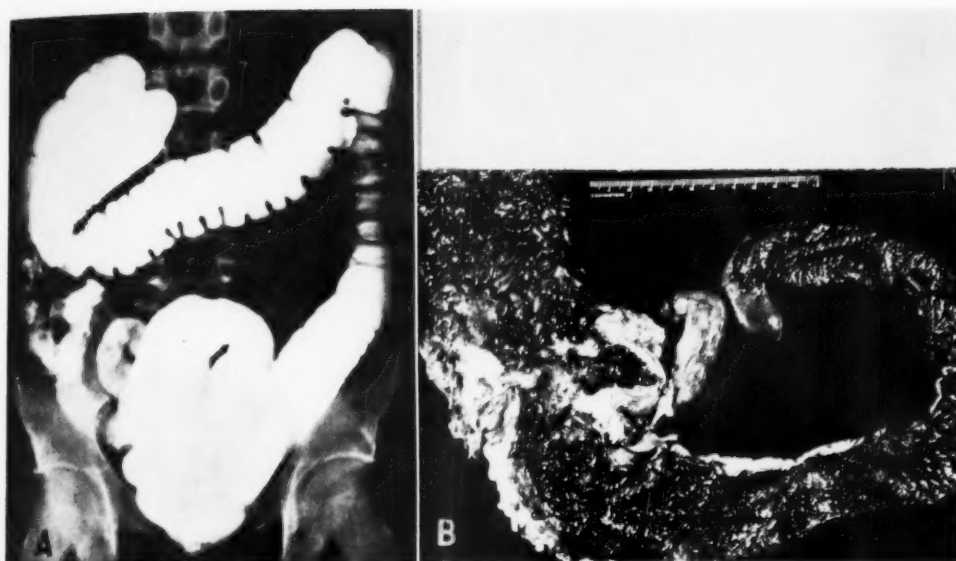


Fig. 7. A. Another instance of granulomatous ileocolitis with findings similar to those in Figure 6. B. Specimen again reveals marked ulceration, thickening of the wall, and large inflammatory polyps.

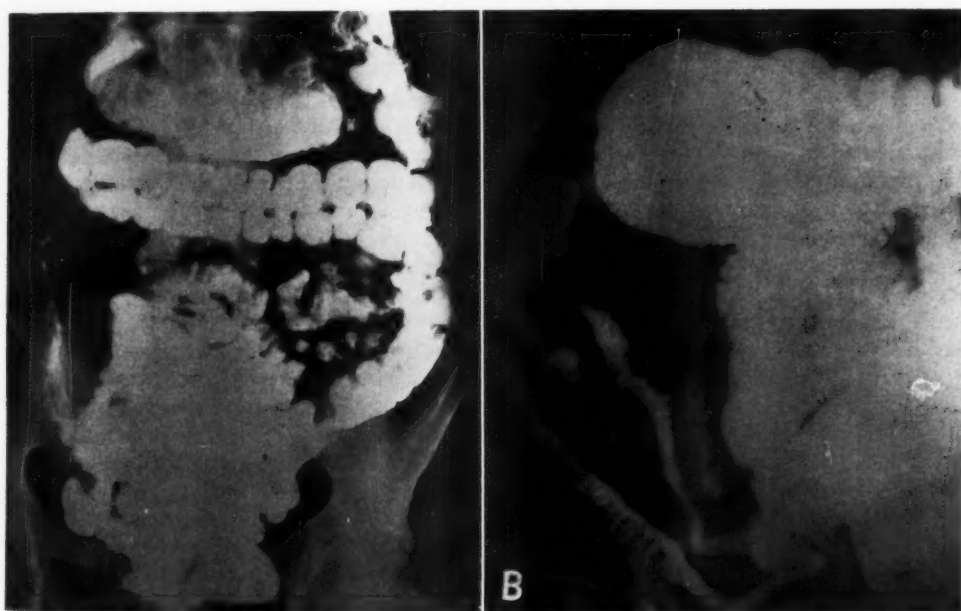


Fig. 8. A. Marked spasm and irritability, narrowing of the lumen, numerous sinus tracts involving the terminal ileum, cecum, and ascending colon in a patient with regional enteritis and segmental granulomatous colitis. B. The findings in the terminal ileum are characteristic of regional enteritis, with marked narrowing, rigidity, effacement of the mucosa, and separation of the loops of bowel. The findings in the right side of the colon are due to segmental granulomatous colitis. This is presumably a more chronic stage than that in A.

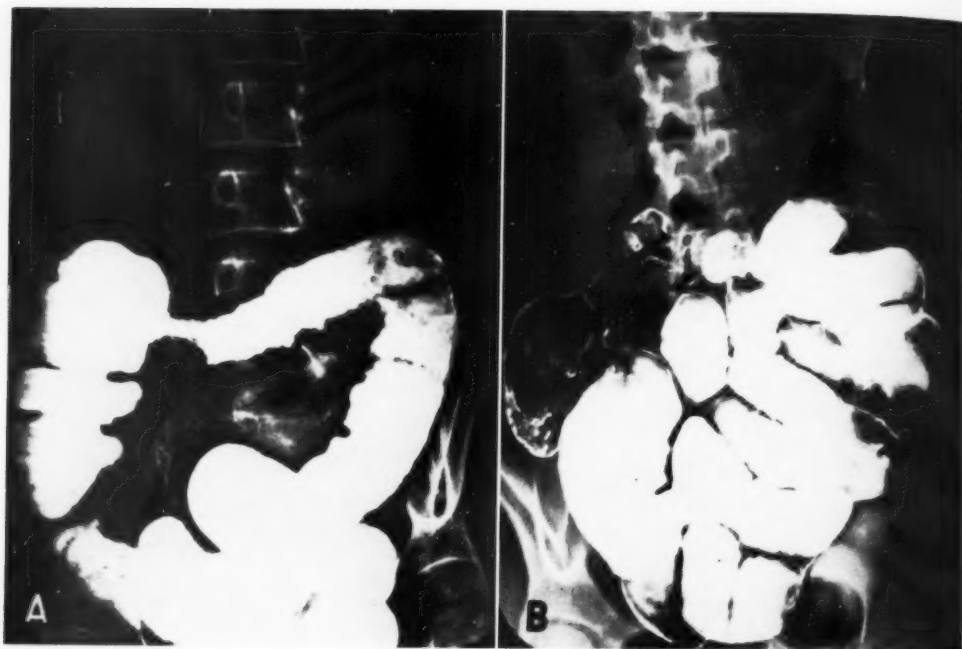


Fig. 9. A. Segmental granulomatous colitis of the transverse colon occurring in combination with typical regional enteritis. The intervening colon is uninvolved. B. An unusually short well demarcated segmental narrowing caused by segmental granulomatous colitis mimicking a carcinoma.

instances were characterized by an abrupt transition from diseased to normal bowel. The inflammatory polyps were larger and skip lesions were not unusual. The ulcerations were deep and linear. The lymph nodes were frequently enlarged, similar to regional enteritis. On gross inspection it was often possible to suspect that the process was granulomatous. The most important pathologic criterion at the present time must remain the identification of multiple granulomas on microscopic examination. Granulomas may occur in ulcerative colitis but are usually few in number.

Of interest are the types of recurrences developing in these cases following ileosigmoidostomy, the most frequently performed surgical procedure. The usual recurrence is granulomatous, involving the new terminal ileum at the anastomosis (Fig. 3, B). In 1 patient, there was both granulomatous disease in the new terminal ileum and ulcerative disease in the rectum.

Granulomatous colitis after an ileotransverse colostomy was noted in 2 patients. In general, the results of operative procedures were better than with segmental ulcerative colitis and recurrences were less frequent.

#### DISCUSSION

The study of non-specific inflammatory conditions involving only a segment of the colon has been difficult because of the lack of a known etiology, a variety of interpretations of the pathologic changes observed, and a confusing and increasing nomenclature. It is not entirely surprising, therefore, that the radiologist has encountered difficulty in identifying the nature of the inflammatory disease in these situations. Numerous terms have been utilized to identify this limited form of colitis; namely, regional colitis, segmental colitis, right-sided ulcerative colitis, regional segmental colitis, and others. The terminology has depended on whether location or

pathology was stressed. Since the disease can affect any segment of the colon, we prefer not to use the term "right-sided." The word "regional" implies a distinct relationship to regional enteritis, which has not been proved. We prefer to call these cases "segmental," with the provision that there is no connotation as to the nature of the underlying process and that the term is used only to denote a limited form of colitis. Since there appear to be two fairly discrete clinical, radiological, and pathologic entities, we have employed the terms "segmental ulcerative colitis" and "segmental granulomatous colitis." Segmental ulcerative colitis resembles diffuse ulcerative colitis in its clinical, pathologic, and roentgenologic behavior except for its limited distribution. The second form, segmental granulomatous colitis, is less well understood and it is about this entity that considerable controversy revolves. Some pathologists regard this condition as a chronic form of ulcerative colitis; others consider it to be regional enteritis of the colon. Still others suggest that it may be a separate disease. At the present time we believe that this entity represents regional enteritis of the colon, for the following reasons:

1. The microscopic changes are frequently similar.
2. The association with regional enteritis is frequent.
3. Following operation, recurrences are usually in the small bowel in the form of regional enteritis.

Differentiation between segmental ulcerative colitis and segmental granulomatous colitis appears to be important because:

1. Granulomatous colitis rarely spreads without operation.
2. Fistula formation is more common in granulomatous than in ulcerative colitis.
3. Acute fulminating episodes with marked dilatation of the colon, perforation, and peritonitis are rare in granulomatous colitis.
4. Granulomatous colitis is frequently associated with regional enteritis.
5. Carcinoma superimposed upon granu-



Fig. 10. In this case of tuberculous colitis with marked irregularity of the contours, large inflammatory polyps, and longitudinal shortening, there is a striking resemblance to segmental granulomatous colitis.

lomatous colitis has not as yet been observed. We have, however, observed 2 cases of long standing regional enteritis associated with carcinoma, but this complication appears to be rare.

6. Recurrences following operation vary in location and nature according to the initial disease; for instance, following granulomatous colitis, the recurrence is usually in the nature of regional enteritis adjacent to the stoma.

Operative intervention in order to prevent spread of the disease to the rectum would appear to be of little value in granulomatous colitis, since extension is rare. It is also true that it may not be helpful in segmental ulcerative colitis because extension to the rectum is common. Therefore, operation would appear to be indicated only for intractable symptoms.

The roentgen criteria for differentiation of granulomatous and ulcerative colitis are as yet not sufficiently well established to permit an unequivocal diagnosis in many



instances. It is necessary also to differentiate these conditions from a variety of other diseases, such as tuberculosis, amebiasis, infarction, malignant disease, and "cathartic" bowel.

Many of the statements made in this paper are based on the present pathologic criteria for distinguishing ulcerative from granulomatous disease. If, in the future, these criteria become more refined or an etiologic or pathogenetic differentiation becomes possible, it is likely that delineation of these conditions will become clearer.

#### SUMMARY

1. The term "segmental colitis" is used to refer to any limited form of colitis.
2. On the basis of pathologic criteria, two forms are identified: segmental ulcerative colitis and segmental granulomatous colitis.
3. An attempt is made to describe the roentgen features which may be helpful in differentiating these two varieties.
4. This differentiation may be of signifi-

cance clinically as an aid in therapy and prognosis.

The Mount Sinai Hospital  
New York, N. Y.

#### REFERENCES

1. WILKS, S., AND MOXON, W.: Lectures on Pathological Anatomy. London, Longmans, 1889, 3d rev., p. 434.
2. BARGEN, J. A., AND WEBER, H. M.: Regional Migratory Chronic Ulcerative Colitis. *Surg., Gynec. & Obst.* **50**: 964-972, June 1930.
3. CROHN, B. B., AND BERG, A. A.: Right-sided (Regional) Colitis. *J.A.M.A.* **110**: 32-38, Jan. 1, 1938.
4. NEUMAN, H. W., AND DOCKERTY, M. B.: Pathology of Regional (Segmental) Colitis. *Surg., Gynec. & Obst.* **99**: 572-579, November 1954.
5. WARREN, S., AND SOMMERS, S. C.: Pathology of Regional Ileitis and Ulcerative Colitis. *J.A.M.A.* **154**: 189-193, Jan. 16, 1954.
6. RAPPAPORT, H., BURGOYNE, F. H., AND SMETANA, H. F.: Pathology of Regional Enteritis. *Mil. Surg.* **109**: 463-502, October 1951.
7. BARGEN, J. A.: What Is Regional Colitis? *Am. J. Digest. Dis.* **2**: 677-679, December 1957.
8. YARNIS, H., MARSHAK, R. H., AND CROHN, B. B.: Ileocolitis. *J.A.M.A.* **164**: 7-13, May 4, 1957.
9. MARSHAK, R. H., AND ELIASOPH, J.: The Problem of Ileocolitis. *Am. J. Digest. Dis.* **3**: 181-203, March 1958.
10. MARSHAK, R. H., AND WOLF, B. S.: Symposium on Regional Ileitis: Roentgen Findings in Regional Enteritis. *J. Mt. Sinai Hosp.* **22**: 192-214, September-October 1955.

#### SUMMARY IN INTERLINGUA

##### Colitis Segmental

Le termino "colitis segmental" es usate pro designar un chronic processo inflammatori que affice un restringite portion del colon, con le provision que per iste uso nihil es dicite con respecto al natura del processo subjacente.

Super le base de criterios clinic, radiologic, e pathologic, duo typos de colitis segmental es identificate: Colitis ulcerative segmental e colitis granulomatose segmental. Le prime resimila diffuse colitis ulcerative, excepte que su distribution es limitate. Colitis granulomatose seg-

mental es interpretate como un enteritis regional del colon proque le alterationes microscopic in illo es frequentemente simile a illos vidite in enteritis regional del intestino tenue, proque le association del duo conditiones es frequente, e proque recurrentias postchirurgic prende usualmente le forma de enteritis regional in le intestino tenue.

Le differentiation inter le duo typos de colitis segmental es importante a causa de differentias in comportamento clinic, prognose, e tractamento.

# Displacement of Fat Pads in Disease and Injury of the Elbow

## A New Radiographic Sign<sup>1</sup>

R. C. BLEDSOE, M.D.,<sup>2</sup> and J. L. IZENSTARK, M.D.<sup>3</sup>

**I**NJURIES, PARTICULARLY linear fractures of the radial head, may be difficult to detect in the routine radiographic study of the elbow (1). Kulowski (4) has expressed the need for more accurate diagnoses in elbow fractures. Meschan (8), without elaborating, has stated that the periarticular soft tissues may show evidence of

Displacement of these pads can also be of aid in evaluating the elbow in those local and generalized disease processes which result in hydrarthrosis.

### ANATOMY

A knowledge of the anatomy of the elbow is pertinent to radiographic inter-

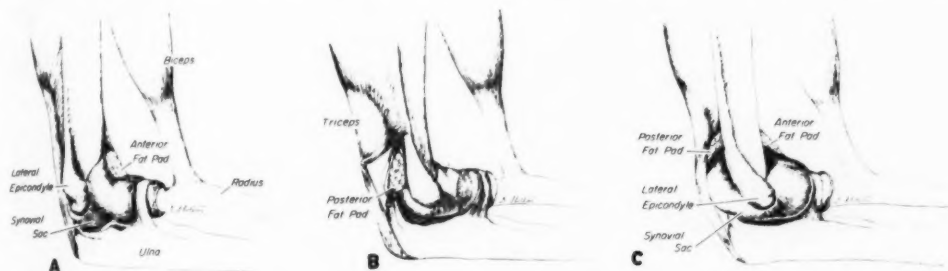


Fig. 1. A and B. Anatomical drawings of normal elbow in 90° flexion. A. Slightly posterior oblique view demonstrating position of anterior fat pads in shallow radial ulna fossae. Note the relationship to the synovial membrane. The fibrous articular capsule has been omitted from the anterior part of the drawing for better visualization. B. Slightly anterior oblique view demonstrating position of posterior fat pad lying upon the synovial membrane and recessed within the relatively deep olecranon fossa. The tendinous covering has been retracted for better visualization of the fat pad.

C. Anatomical drawing in true lateral position, showing fluid distending synovial sac and displacement of anterior and posterior fat pads. Note how the annular ligament binds the synovial membrane about the neck of the radius. The radial head is within the joint enclosed by the articular capsule, which is not shown, and completely surrounded by but not actually within the synovial sac.

swelling. Norell (9), in an excellent observation, has described fat pad displacement about the humeral fossae in the presence of fractures involving the elbow joint, although he erroneously described the fat as "extracapsular." A survey of the American radiological and orthopedic literature fails to reveal any report of this "fat pad sign." The purpose of the present paper is to show that the pads described by Norell are "extrasynovial" and "intracapsular," and to demonstrate further their value in radiographic interpretation of obscure elbow joint injuries.

Gray (6) and other anatomists (2, 3, 7, 11) depict the fat pads as intracapsular and extrasynovial in contradistinction to the "extracapsular" location cited by Norell.

According to Gray's *Textbook of Anatomy* (6) the articular capsule is a thin, broad, fibrous covering attached anteriorly to the medial epicondyle, and to the front of the humerus immediately above the coronoid and radial fossae; below to the anterior surface of the coronoid process of the ulna, and to the annular ligament. The posterior part is thin and membranous

<sup>1</sup> Accepted for publication in April 1959.

<sup>2</sup> Instructor in Radiology, College of Medical Evangelists, Los Angeles, Calif.; Radiologist, Kaiser Foundation Hospital, Harbor City, Calif.

<sup>3</sup> Radiologist, VA Hospital, Long Beach, Calif.; Attending Radiologist, Harbor General Hospital, Torrance, Calif. Now Director, Department of Radiology, Imperial Hospital, Inglewood, Calif.



Fig. 2. Injection of opaque contrast medium into the elbow joint of a cadaver. A. Needle in position prior to injection. A small amount of medium has been deposited about the triceps tendon. Note the oblique radiolucency anterior to the distal humerus. B. Five cubic centimeters of the medium has been injected. Note the upward displacement of the anterior radiolucency and the slight impression made on the distended synovial membrane. C. Ten cubic centimeters has been deposited and there is further distention of the synovial sac, with slight posterior bowing of the triceps tendon. The medium is beginning to extravasate through the synovial membrane into the retrohumeral area, obscuring the posterior fat pad. D. With 15 c.c. of contrast medium, further posterior extravasation occurs.

attached above to the humerus immediately behind the capitellum and close to the medial margin of the trochlea, to the margins of the olecranon fossa, and to the back of the lateral epicondyle. Below it is fixed to the upper and lateral margins of the olecranon, to the posterior part of the annular ligament, and to the ulna behind the radial notch. Transverse fibers form

a strong band which bridges the olecranon fossa. Under cover of this band, a pouch of synovial membrane and a pad of fat project into the upper part of the fossa when the joint is extended. The capsule is in relation posteriorly with the tendon of the triceps brachii and the anconeus.

The synovial membrane is described by Gray as extending from the margin of the

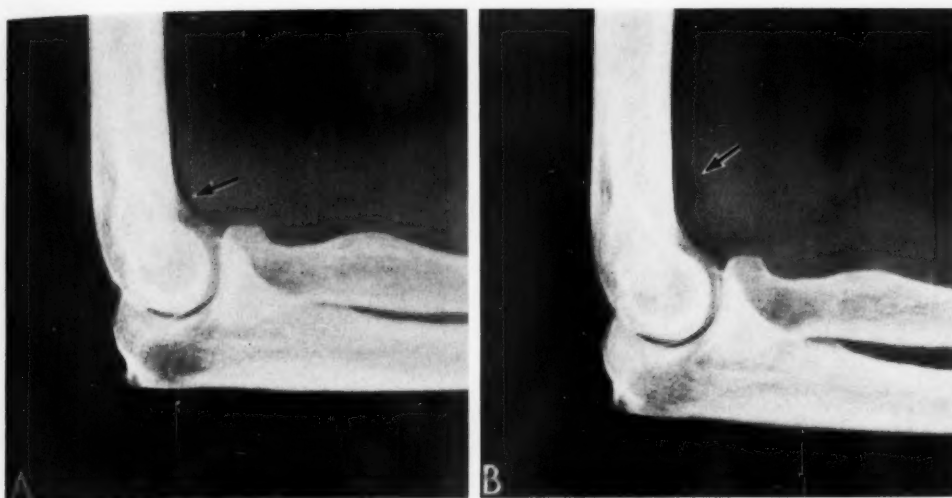


Fig. 3. A. Lateral radiograph of normal cadaver elbow in 90° flexion. The oblique narrow area of radiolucency indicated by the arrow represents the anterior fat pads. B. After injection of 10 c.c. of water these fat pads can be visualized displaced upward and anteriorly.

articular surface of the humerus to line the coronoid, radial, and olecranon fossae of that bone. It is then reflected over the deep surface of the tendinous capsule of the joint to form a pouch between the radial notch, the deep surface of the annular ligament, and the circumference of the radial head. The radial head is thus surrounded almost completely by synovial membrane, although not actually within the synovial sac. Between the capsule and the synovial membrane are three masses of fat, each occupying one of the three fossae (Fig. 1). The largest fat pad, within the deep posterior olecranon fossa, is pressed into the fossa by the triceps brachii during flexion; the other two occupy the shallower anterior coronoid and radial fossae, into which they are pressed by the brachialis during extension.

#### EXPERIMENTAL OBSERVATIONS

To confirm displacement of the fat pads by fluid, several cadaver elbows were injected with different contrast media. A needle was introduced into the joint space both anteriorly and posteriorly, and various amounts of contrast medium were injected. Radiographs were taken following each injection to demonstrate the fat pad dis-

placement. Figure 1, C is an anatomical drawing depicting the fat pads after the synovial capsule has been distended with fluid. Figure 2 shows the elbow joint of a cadaver into which opaque contrast medium has been injected. This demonstrates radiographically the extent of the synovial cavity, anterior displacement of the anterior fat pad, and posterior bulging of the triceps tendon. The synovial sac can be visualized bound down by the annular ligament and surrounding the neck of the radius. The injected specimens all showed variable displacement of the fat pads, the degree of displacement, and the extent of associated changes being dependent upon the amount of fluid present. Comparison views before and after injection of 10 c.c. of water into the joint cavity are reproduced in Figure 3. Figure 4 illustrates displacement of the anterior fat pad when 5 c.c. of air was used as contrast medium. As much as 30 c.c. of fluid could be injected in some specimens before the synovial sac ruptured.

#### RADIOGRAPHIC INTERPRETATION

A true lateral view of the elbow with the joint flexed at right angles is the optimum position for visualizing the fat pads. The



Fig. 4. A. Normal cadaver elbow. B. After 5 c.c. of air has been injected. The distention is not great enough to produce much displacement of the fat pad, which is seen anteriorly through the air lucency.

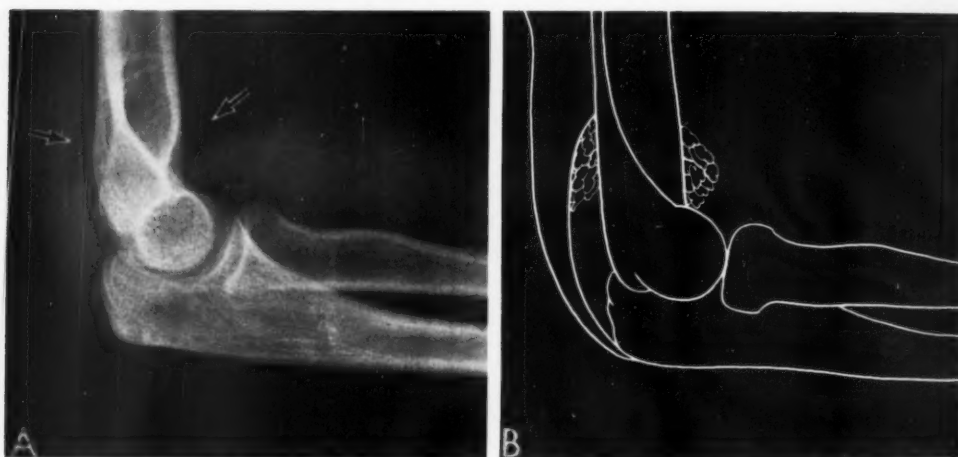


Fig. 5. A. Lateral radiograph of 13-year-old girl who fell on her elbow, incurring a traumatic bursitis. No fracture was demonstrated. Arrows indicate anterior and posterior radiolucencies representing, respectively, displaced anterior and posterior fat pads. Note the concavity inferiorly in the posterior fat pad due to the impression of the distended synovial sac; also the rounded posterior contour of the triceps tendon. B. Line drawing traced from A, with the fat pads indicated as fat globules.

radial surface of the forearm is uppermost. The central ray is perpendicular to the film and is directed over the radial head.

Since some fractures may be seen only in the oblique projection, our routine procedure calls for four views of the elbow. Our technic is such that satisfactory bone detail and soft-tissue visualization are obtained. If further detail is desired, the

technic and positions may be varied or, rarely, magnified views may be indicated. When forearm films are made of children in suspected trauma, every effort should be made to include a true lateral view of the elbow so that the joint can be surveyed for fluid.

Due to the difference in x-ray absorption between fat, muscular tissue, and bone,





Fig. 6. A. Lateral view of 15-year-old girl who fell on her elbow incurring traumatic bursitis. No fracture was demonstrated. Note posterior fat pad and bulging of triceps tendon. B. Oblique view, also demonstrating posterior fat pad and bulging of triceps tendon.

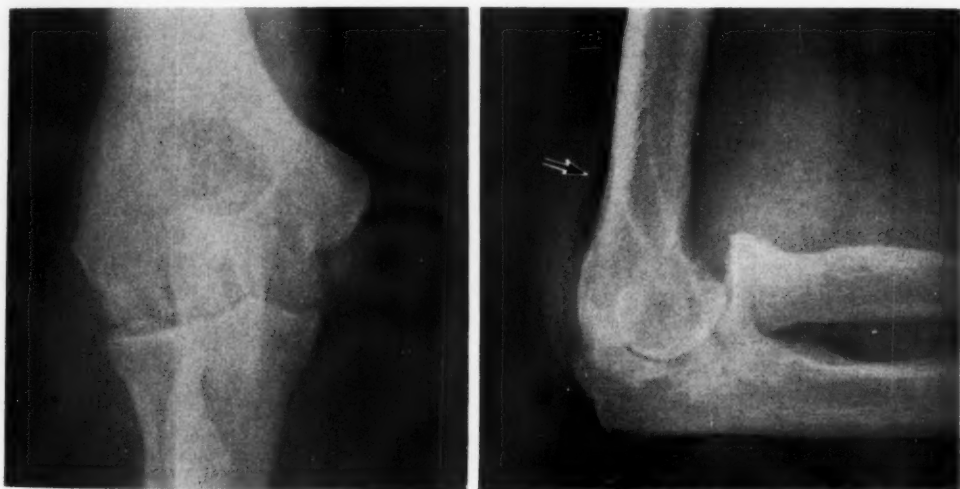


Fig. 7. Elbow of a 61-year-old white male with rheumatoid arthritis. Note the destructive subchondral bone changes. The posterior fat displacement is clearly seen in the lateral view.

the fat is readily recognizable in the radiograph. The two anterior fat pads which fit into the coronoid and radial fossae are seen as a single triangular area of radiolucency on the lateral flexion view of the normal elbow (Figs. 3 and 4). The anterior border forms a straight oblique line. When the synovial fluid is increased, the anterior surface may be straight or slightly convex and the inferior surface concave, due to

pressure by fluid causing upward displacement of the fat pads (Fig. 5).

The posterior fat pad is normally not visible on the lateral flexion view of the elbow because it lies deep in the olecranon fossa and is overshadowed by overlying bone (Fig. 1, B). When displaced, this pad may be seen as a radiolucent area posterior to the humerus at the upper border of the olecranon fossa (Fig. 5).



Fig. 8. Elbow of a 25-year-old female, tender and painful following a fall. A. Posterior fat radiolucency is well demonstrated in an otherwise normal appearing lateral view. Anteriorly the fat pads are distorted and pushed upward. B. Oblique view confirming fat pad displacement. C. Anteroposterior view showing a small linear fracture in the posterior part of the radial head. D. Magnified view better demonstrating the linear fracture.

Often the lower margin of the displaced fat pad is concave, due to the impression of the fluid, the density of which simulates muscular tissue roentgenographically.

A frequently associated finding in the presence of increased fluid in the joint is posterior displacement of the triceps brachii tendon as it curves around the distended capsule. This is viewed as a slight posterior bulging of the tendon bordered by the subcutaneous fat in the lateral and oblique views (Figs. 5 and 6).

#### DISCUSSION

Lewis (5) has stated that soft-tissue involvement about the elbow is not so well shown or so distinctive as in some of the other joints. The demonstration of fat pad displacement as described above is suggestive evidence of injury or disease about the elbow. It is important, however, to bear in mind that bursitis (Figs. 5 and 6) may occur within the elbow joint and result in synovial effusion which would distend the synovial sac and cause dis-

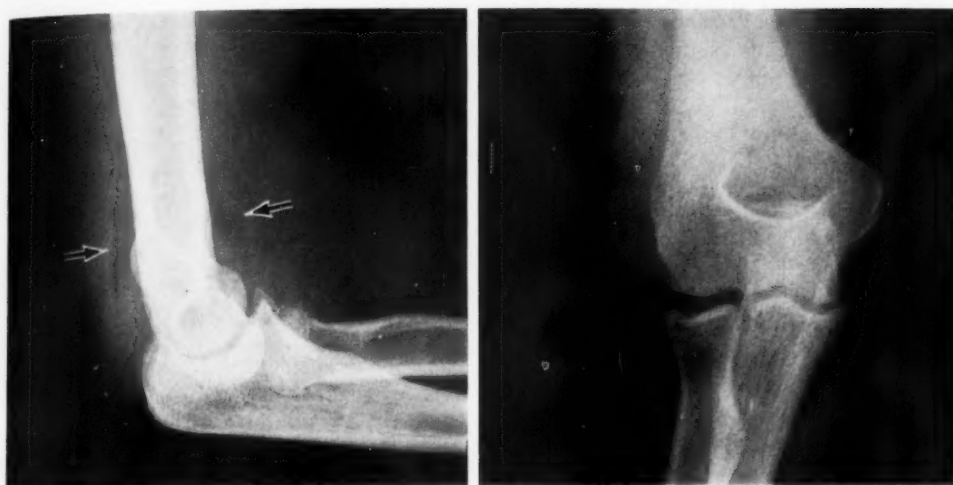


Fig. 9. Fracture of the radial head in a 26-year-old female. The radiolucencies representing anterior and posterior fat pad displacement are clearly evident.

placement of the fat pads. In fact, bursitis may occur and be indicative of such systemic diseases as gout and rheumatoid arthritis (9). Figure 7 demonstrates joint effusion in rheumatoid arthritis. One case, with effusion in the elbow joints bilaterally, associated with destruction of the olecranon and soft-tissue masses, proved to be gouty arthritis with large tophi. Fluid in the elbow joint has also been visualized in a case of sickle-cell anemia. Breimer and Freiburger (1), in an article on villonodular synovitis, illustrate their Case VI and call attention to the lobular swelling of the synovium. Their illustration also discloses displacement of the anterior and posterior fat pads, although this was not mentioned by the authors.

Varying degrees of displacement of fat pads have been noted in gross and minute fractures of the elbow; the amount of fluid is not necessarily indicative of the site or size of the fracture. Figure 8 illustrates a small linear fracture in the head of the radius with gross fat pad displacement, while Figure 9 shows evidence of gross fat pad displacement associated with an obvious fracture of the elbow joint.

Traumatic rupture of the synovial membrane and articular capsule may permit

the fluid to escape into the surrounding soft tissues, so that there is no synovial distention and consequently displacement of the fat pads does not occur. Nor does a fracture involving bone outside of the synovial membrane necessarily produce synovial effusion, since the fracture does not communicate with the synovium. Therefore, displacement of the fat pads does not necessarily occur. Similarly, in olecranon bursitis, effusion within the articular joint space is often absent and fat pad displacement is not seen.

When there has been a history of elbow trauma, and physical findings are compatible with a fracture, every effort should be expended to rule out the latter diagnosis if routine radiographs disclose fat pad displacement but fail to demonstrate a fracture. It has been our experience that the fluid has been partially or completely resorbed in most cases of trauma when follow-up films are made two to three weeks later.

#### SUMMARY

1. A new sign of fracture involving the elbow joint, first described by Norell (9) in the Swedish literature, but not previously reported in the American radiological or orthopedic literature, which we have

chosen to call the "displaced fat pad sign," is described. This sign is particularly useful in the diagnosis of obscure fractures of the elbow.

2. The anatomy and roentgen interpretation are described. Any process producing synovial or hemorrhagic effusion within the elbow joint will displace the intracapsular, extrasynovial fat pads. These pads can be detected in radiographs as radiolucent areas anterior and posterior to the distal end of the humerus.

3. An additional useful finding is posterior bulging of the triceps brachii tendon in the presence of elbow joint effusion.

4. The significance of displacement of the fat pads was confirmed by injecting cadaver elbows with water and radiopaque media.

5. The "fat pad sign" may be absent in those cases where the fracture does not communicate with the synovium, or when the joint capsule has been ruptured, allowing extravasation of fluid into surrounding soft tissue.

**ACKNOWLEDGMENT:** The authors wish to express their appreciation to Drs. Ralph Fargotstein and Jay Gore of Harbor General Hospital, Torrance, Calif., for their permission and assistance in obtaining the radiographs of the cadaver specimens; to Dr. Ross Golden for his critical review and helpful

comments; and to the Medical Illustration Department of Long Beach VA Hospital for the preparation of the illustrations.

1100 West Pacific Coast Highway  
Harbor City, Calif.

#### REFERENCES

1. BREIMER, C. W., AND FREIBERGER, R. H.: Bone Lesions Associated with Villonodular Synovitis. *Am. J. Roentgenol.* **79**: 618-629, April 1958.
2. CALLANDER, C. L.: *Callander's Surgical Anatomy*. Philadelphia, W. B. Saunders Co., 3d Ed., edited by Barry J. Anson and Walter G. Maddock, 1952.
3. CUNNINGHAM, D. J.: *Cunningham's Textbook of Anatomy*. New York, Oxford University Press, 9th Ed., edited by James Couper Brash, 1951.
4. KULOWSKI, J.: Fractures of the Elbow Joint: New Classification and Roentgenologic Guide to Major Pitfalls of Diagnosis and Treatment. *Am. J. Roentgenol.* **79**: 692-696, April 1958.
5. LEWIS, R. W.: *The Joints of the Extremities: A Radiographic Study. Notes on Non-Routine Methods, Non-Routine Ideas, and Less Common Pathology*. Springfield, Ill., Charles C Thomas, 1955.
6. GRAY, H.: *Gray's Anatomy of the Human Body*. Philadelphia, Lea & Febiger, 24th Ed., edited by W. H. Lewis, 1942.
7. MESCHAN, I., AND FARRER-MESCHAN, R. M. F.: *An Atlas of Normal Radiographic Anatomy*. Philadelphia, W. B. Saunders Co., 1951.
8. MESCHAN, I.: *Roentgen Signs in Clinical Diagnosis*. Philadelphia, W. B. Saunders Co., 1956.
9. NORELL, H. G.: Roentgenologic Visualization of the Extracapsular Fat: Its Importance in the Diagnosis of Traumatic Injuries to the Elbow. *Acta radiol.* **42**: 205-210, September 1954.
10. SANTE, L. R.: *Principles of Roentgenological Interpretation*. Ann Arbor, Mich., Edwards Bros., 10th Ed., 1944.
11. WOERDEMAN, M. W.: *Atlas of Human Anatomy: Descriptive and Regional*. Philadelphia, Blakiston Co., 1950, Vol. I.

#### SUMMARY IN INTERLINGUA

##### Displaciamento del Cossinos de Grassia in Morbo e Vulneration del Cubito: Un Nove Signo Radiographic

Le signo del displaciate cossino de grassia, primo describe in le litteratura svede, es particularmente utile in le diagnose de obscur fracturas del cubito. Omne processo que resulta in effusion synovial o hemorrhagic inter le articulation del cubito effectua le displaciamento del cossinos de grassia intracapsular e extrasynovial. Iste cossinos pote esser detegite in le radiogramma como areas radioluciente anterior e posterior al termino distal del humero.

Un utile constataction additional es le

protrusion posterior del tendine del tripite brachial in le presentia de effusion in le articulation cubital.

Le signification del displaciamento del cossinos de grassia esseva confirmate per le injection, in cubitos de cadavere, de aqua e substantias radio-opac.

Le "signo del cossino de grassia" pote esser absente in casos in que le fractura ha nulle communication con le synovio o quando le capsula articular es rupturate con le consequente extravasation de liquido in le circumjacente histos molle.

# Diagnosis of Esophageal Varices by a New Radiologic Method

## A Preliminary Report<sup>1</sup>

M. H. NATHAN, M.D.

UNTIL THE LAST few years, the diagnosis of esophageal varices carried a prognosis worse than most other diseases, including coronary occlusion and cancer. The statistics vary but demonstrate similar results. Higgins (1) found that 84 per cent of those entering the hospital complaining of hematemesis died of hemorrhage. Blakemore (2) refers to the experience of Patek, who found that 50 per cent of his patients with Laennec's cirrhosis were dead within one year of the onset of their first hemorrhage. Palmer (3) quotes from Shull's experience: only 37 per cent of 180 cirrhotic patients were alive one year after the diagnosis of esophageal varices was made.

The employment of the Sengstaken tube (4) and of relatively new surgical methods, especially the portacaval and splenorenal shunts, in the last few years, have offered hope of improving these statistics considerably, and prophylactic surgery for esophageal varices prior to hemorrhage is being seriously considered as the proper method of management. Therefore, the early diagnosis of esophageal varices has become much more important.

### PRESENT DIAGNOSTIC METHODS

At the present time, only three acceptable antemortem methods of diagnosis are available: esophagoscopy, splenoportography, and roentgen study of the esophagus.

*Esophagoscopy* offers the most accurate method of diagnosis, although occasionally a roentgen examination of the esophagus with the aid of barium has demonstrated varices which have been overlooked by the esophagoscopist (5). In spite of the fact that there is a morbidity rate (perforation of the esophagus, hemorrhage) of only 2 per cent or less and a mortality rate of

0.5 per cent or less associated with all esophagoscopy (5, 6), many physicians are reluctant to use the procedure in the presence of esophageal varices. In addition, about 8 per cent of patients refuse to undergo this examination (5).

Percutaneous *splenoportography* as yet enjoys only a limited use in the United States, and no large series on the study of esophageal varices by this technic is available. At the present time, it appears to be a less accurate method than esophagoscopy and no more accurate than conventional x-ray examination of the esophagus (7).

The advantages of *roentgen examination of the esophagus* are the absence of associated mortality or morbidity and ease of application. The disadvantage of this method is its low percentage of accuracy, though differences of opinion on this point are found among radiologists, who claim as little as 15 and as much as 50 per cent positive diagnoses in all cases of esophageal varices, both with and without a history of hematemesis (8, 9). A study of this type of examination was made by Brick and Palmer on the basis of a total of 172 patients examined in three separate university radiology departments under the direction of three different radiologists (10). Sixty-four of this series had a history of hemorrhage, while 108 were without such a history. Each radiologist was asked to look especially for esophageal varices, yet the overall accuracy was only about 22 per cent of those cases which could be diagnosed by esophagoscopy. Brick and Palmer suggest an "intensive effort to improve the present roentgenologic method of diagnosis."

The performance of prophylactic surgery requires, of course, the early diagnosis of varices, prior to a bleeding episode. Such

<sup>1</sup> From the Department of Radiology, Baylor University College of Medicine, and Jefferson Davis Hospital, Houston, Texas. Presented at the Forty-fourth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 16-21, 1958.



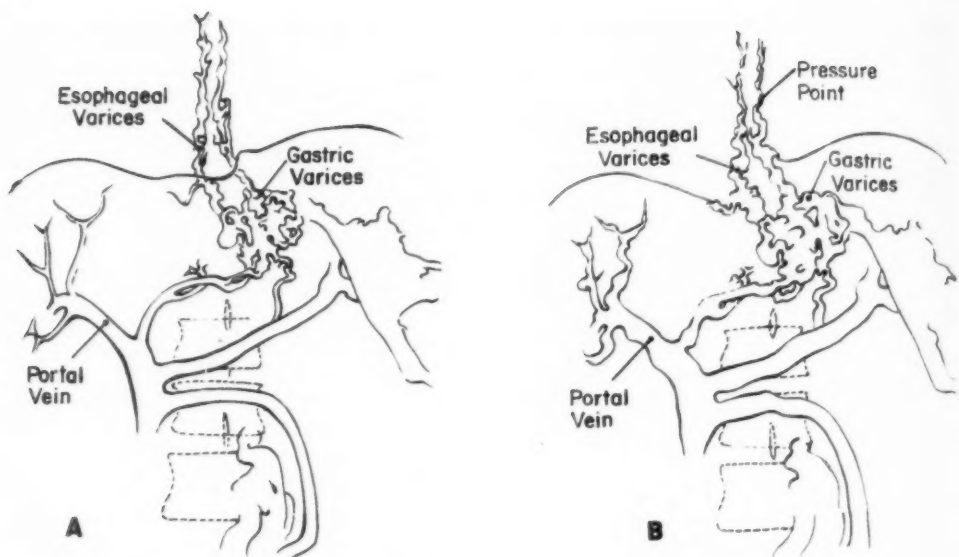


Fig. 1. A. Drawing representing increased pressure in the portal system with associated esophageal varices. B. Compression of the esophageal veins at a point near the junction of the middle and distal thirds causes increased resistance to cephalad blood flow with resultant further distention of the esophageal veins.

early diagnosis depends largely on the radiologist for, although the esophagoscopist can provide a higher degree of accuracy in the diagnosis of this disease, both the physician and the patient hesitate to accept this examination.

#### THE CONVENTIONAL ROENTGEN METHOD

With the above facts in mind, an effort was made to improve our diagnostic accuracy by employment of means that would accentuate the radiographic appearance of varices. Valsalva and Müller maneuvers were employed in an effort to increase the size of the esophageal veins; inspiratory and expiratory phases, and suspended respiration were utilized with the patient standing, prone, supine, and in 60° Trendelenburg position. Abdominal compression was also tried. Thick and thin barium suspensions were used; the esophagus was visualized both full of the barium suspension and with the mucosa only coated. Multiple views were, of course, necessary to carry out this investigation. These studies have been performed by others, many of whom give

conflicting recommendations as to the best radiological procedures.

Valsalva and Müller maneuvers to increase intravenous blood in the esophagus were found to be of no practical value; this corresponds to Schatzki's experience (9).

As to advantages of any one position over another, no particular difference was noted except that it was easier to examine most of our patients in the supine position. Also, small amounts of barium were more easily retained in the esophagus in the horizontal or Trendelenburg position than with the patient upright.

The phase of respiration seems to be of little importance. Deep inspiration seems to offer no disadvantage in demonstrating varices as compared to suspended respiration, despite Butler's suggestion that it is possible that contraction of the diaphragm may compress the veins of the esophagus and suspend blood flow (10). Expiration rarely may cause confusion, however, in that folds of the esophageal wall may be difficult to differentiate from "scalloping."

The projection of the esophagus on films

at 90° to each other, as recommended by Schatzki (9), would seem advantageous, since it is possible that only one varix may be of sufficient size to be demonstrated in a single plane.

Of greatest importance in diagnosis of esophageal varices is the use of multiple films, even when made in the same position, since the visibility of varices changes from one moment to the next. Their disappearance can frequently be explained by the occurrence of peristaltic waves which seem to compress the veins. In the absence of peristalsis, their disappearance probably results from changing intrapulmonary and venous pressures.

Following the employment of some of the refinements of radiographic technic mentioned, multiple views in particular, improvement in diagnostic accuracy was apparent but left much to be desired. The single most important reason for the improvement seems to have been the greater interest in this disease and the greater effort made to demonstrate varices.

#### A NEW RADIOLOGIC METHOD

In normal individuals, it is not possible to say how much of the esophagus drains into the caval system and how much into the portal system; the direction of blood flow may vary during respiration (11). However, with elevation of pressure in the portal system, the blood flow is from that system into the esophageal veins, as demonstrated pictorially by splenoportography. The veins of the lower esophagus drain into the azygos, hemiazygos, and intercostal veins only after numerous anastomoses. Esophageal varices resulting from portal hypertension always occur in the lower third of the esophagus, being found progressively less often as the proximal end is approached (12).

In view of this anatomy and the physiologic changes which occur with increased pressure in the portal system, it seems likely that increase in resistance to blood flow near the junction of the mid and distal thirds (Fig. 1) should result in increased distention of the esophageal veins in the

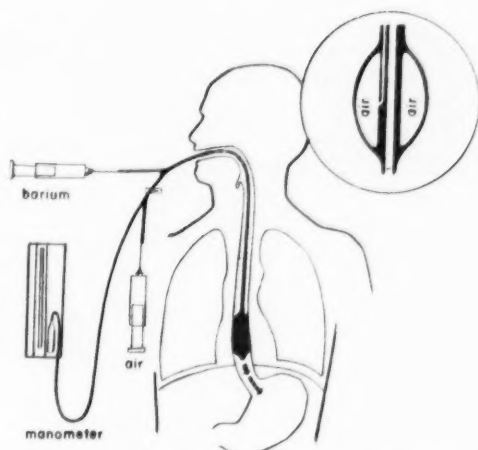


Fig. 2. Drawing representing the double lumen tube with the balloon near the junction of the middle and distal thirds of the esophagus and with barium being injected below the site of the balloon. The inset is a diagrammatic representation of the tube at the level of the balloon.

lower third of the esophagus. Should this happen, then the veins should be more easily visualized upon examination of the esophagus.

To investigate this possibility, a double-lumen tube with an inflatable balloon at its distal end was passed through the mouth to a point immediately below the junction of the middle and distal thirds of the esophagus and was distended with air (Fig. 2). Early in the use of this method, the balloon was distended very slowly up to a point where substernal discomfort occurred; a small amount of air was then released to relieve this discomfort. At the present time, a manometer is employed, and air, to a pressure of 650 mm. of water,<sup>2</sup> is measured into the balloon to overcome the highest expected esophageal venous pressure (3). Barium is next instilled through the tube into the distal esophagus below the balloon and spot-films are made with the patient 15° left posterior oblique, 15° right anterior oblique, and 60° right posterior oblique while in horizontal position. The Trendelenburg position was deleted from the procedure when no advantage could be

<sup>2</sup> The minimum pressure required to perforate the esophagus has been found to be 1.9 pounds per square inch, approximately 1,300 mm. of water (13).



Fig. 3. Case I: Conventional radiographic technic, showing an apparently normal esophagus.



Fig. 4. Case I: Esophageal varices demonstrated after inflation of the balloon near the junction of the middle and distal thirds of the esophagus.

ascribed to its use. A water-barium mixture, 2 to 1 ratio by volume, is utilized, and multiple spot films of the esophagus, when it is full and when it is only coated with barium, are made on moderate inspiration and on slight expiration.

Vomiting proved to be a frequent complication to passage of the tube through the mouth, and administration of antiemetics, 50 mg. Thorazine intramuscularly and 2 per cent Pontocaine spray applied to the pharynx, were of only slight benefit in preventing this. It was not until the technic was altered and the tube passed through the nose that vomiting was satisfactorily controlled. In addition to Thorazine and Pontocaine spray, the patient is prepared with 50 to 100 mg. Demerol intramuscularly to lessen apprehension and discomfort.

**Results:** Twenty-seven examinations were performed by this technic on 24 patients. The presence of varices was confirmed in 5 cases (by surgery in 4; by esophagoscopy in 1) and their absence in 5 (by surgery in 3; by esophagoscopy in 1; postmortem in 1). In 14 cases surgery was not performed and there was no follow-up. The results are further

TABLE I: ESOPHAGEAL VARICES FOUND AT SURGERY (4 CASES) AND AT ESOPHAGOSCOPY (1 CASE)

Case	Usual Radiographic Technic	Balloon Technic
I	0	+++
II	0	++
III	0	+++
IV	++	++++
X	++	++++

TABLE II: NO ESOPHAGEAL VARICES FOUND AT SURGERY (3 CASES), AT ESOPHAGOSCOPY (1 CASE), OR POSTMORTEM (1 CASE)

Case	Usual Radiographic Technic	Balloon Technic
V	+	0
VI	0	0
VII	0	0
VIII	0	0
IX	0	0

summarized in Tables I and II. The first patient in whom the method was attempted had been admitted with a history of hematemesis. An examination of the esophagus, stomach, and duodenum by the conventional method showed no abnormality. Re-examination of the esophagus by the "balloon" technic demonstrated varices which were proved at surgery. Two other cases were similarly

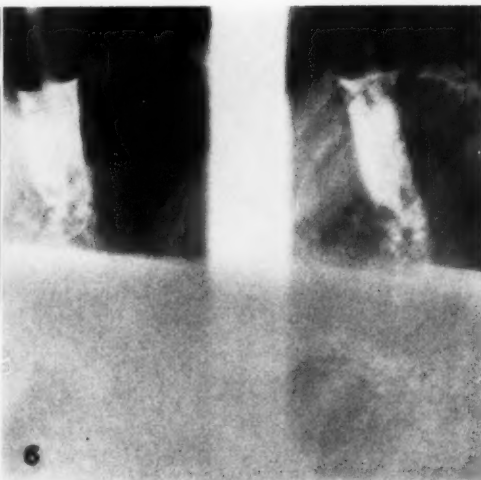
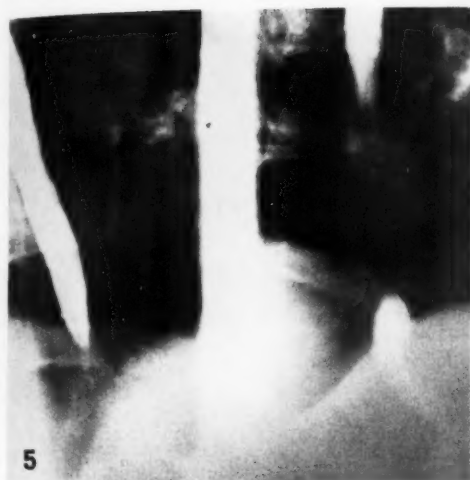


Fig. 5. Case II: Conventional radiographic technic showing "normal" esophagus.

Fig. 6. Case II: Demonstration of esophageal varices with use of the "balloon" technic.

diagnosed by the use of the "balloon" technic only, but in both instances this was done after operation. No false positive results have been obtained and in a few instances esophageal varices suspected from the appearance on routine examination were ruled out by the use of the "balloon" technic.

The most desirable location of the balloon was found to be near the junction of the mid and distal esophagus. After placing the tube in the correct position, under fluoroscopic control, inflation of the balloon frequently resulted in marked increase in esophageal peristalsis with consequent caudal movement of the tube below the optimal site. With the tube fixed at the mouth or nose with adhesive tape the considerable pull exerted upon it by the powerful peristaltic impulses sometimes caused discomfort in the soft parts of the mouth or nose. When atropine sulfate was employed, peristalsis was diminished.

**CASE I:** I. S., a 40-year-old woman, a chronic alcoholic for more than twenty years, with a clinical diagnosis of cirrhosis of the liver, was admitted because of hematemesis. Over the past six years she had experienced recurrent bouts of anorexia, nausea, vomiting, and jaundice; ascites had been present for three years and three paracenteses had

been required. Two previous episodes of hematemesis had occurred during the last two years.

Examination of the esophagus, stomach, and duodenum revealed no abnormalities. Re-examination of the esophagus with the conventional technic was again negative (Fig. 3), but obvious varices were demonstrated when the "balloon" technic was utilized (Fig. 4). The radiographic diagnosis of esophageal varices was confirmed by splenoportography, and the patient was treated for approximately two weeks with transfusions and a Sengstaken tube. Bleeding subsided and liver function tests improved. At surgery, esophageal varices were found and an end-to-side portacaval shunt was performed.

**CASE II:** J. F., a 37-year-old white male, had been a chronic alcoholic for fifteen years. He gave a history of melena in 1956 and again in 1957. He was admitted because of a third episode of severe hematemesis and bright red blood in the stools. Several blood transfusions were administered. A Sengstaken tube was passed but did not control the bleeding. At exploratory laparotomy, performed as an emergency measure, a bleeding varix in the region of the gastric cardia was ligated. The patient was in poor condition and the abdomen was closed without further surgical procedures. No x-ray studies had been performed prior to this time. Later, two conventional barium studies of the esophagus were normal (Fig. 5). The "balloon" technic demonstrated esophageal varices (Fig. 6).

**CASE III:** G. S., a 48-year-old white male with a long history of alcoholism, entered the hospital because of severe hematemesis. Examination of the esophagus, stomach, and duodenum disclosed an apparent deformity of the duodenal bulb and a suggestion of an ulcer crater; the esophagus was



Fig. 7. Case III. An apparently normal esophagus demonstrated by the conventional radiographic technic.

normal by conventional roentgen studies. The patient continued to bleed and emergency surgery revealed a bleeding gastric varix near the cardia, and this was ligated. No abnormality was found in the duodenum. Although the patient was hypotensive during the operation and there was partial collapse of veins, the surgeon was able to demonstrate esophageal varices. Following recovery, re-examination of the esophagus (Fig. 7), stomach, and duodenum revealed no definite abnormality. The "balloon" technic was then employed and esophageal varices were apparent (Figs. 8 and 9).

CASE IV: T. H., a 56-year-old white male, entered the hospital because of cirrhosis and marked ascites. A few mild episodes of hematemesis had occurred in the past. X-ray examination of the esophagus, stomach, and duodenum was performed and both esophageal and gastric varices were strongly suggested. This suspicion was confirmed by the "balloon" technic, which caused the esophageal varices to become even more prominent. Their presence was confirmed by esophagoscopy and later at surgery. Although a portacaval shunt had been contemplated, this could not be performed because of complications.

CASE V: J. McN., a 59-year-old colored male, gave a history of black tarry stools for one year. X-ray examination of the esophagus, stomach, and duodenum revealed what one examiner felt was evidence slightly suggestive of esophageal varices. Re-examination by both the conventional and "balloon" technics showed a normal esophagus. At surgery, performed for carcinoma of the ascending colon, the absence of varices was confirmed.

CASE VI: W. C. was admitted with severe anemia, a history of chronic alcoholism, and a question of cirrhosis of the liver. The esophagram was negative both with the usual technic and with the "balloon" examination. Esophagoscopy revealed no evidence of varices, which tends to confirm the roentgen findings.

CASE VII: V. F., a 46-year-old white woman, had been vomiting blood for one month and had been on ulcer management during that period. X-ray examinations showed a hiatal hernia but no evidence of esophageal varices. Re-examination by the "balloon" technic confirmed the presence of a hernia and disclosed no varices. Considerable regurgitation occurred into the esophagus but there was no radiographic evidence of ulceration or esophagitis. Surgical repair of the hiatal hernia was performed and no varices were present.

CASE VIII: J. McE., a 56-year-old colored male, was admitted because of hematemesis. He gave a history of intermittent mild hematemesis and melena since the performance of gastrojejunostomy for duodenal ulcer nine years earlier. X-ray examination, by both the regular and "balloon" technics, revealed a normal esophagus. A large benign ulcer was found on the lesser curvature margin of the pars media, and the liver was shown to be quite large, with displacement of the stomach. A post-mortem examination revealed diffuse metastatic liver involvement apparently arising from a bronchogenic carcinoma (demonstrated by x-ray). There was no evidence of esophageal varices.

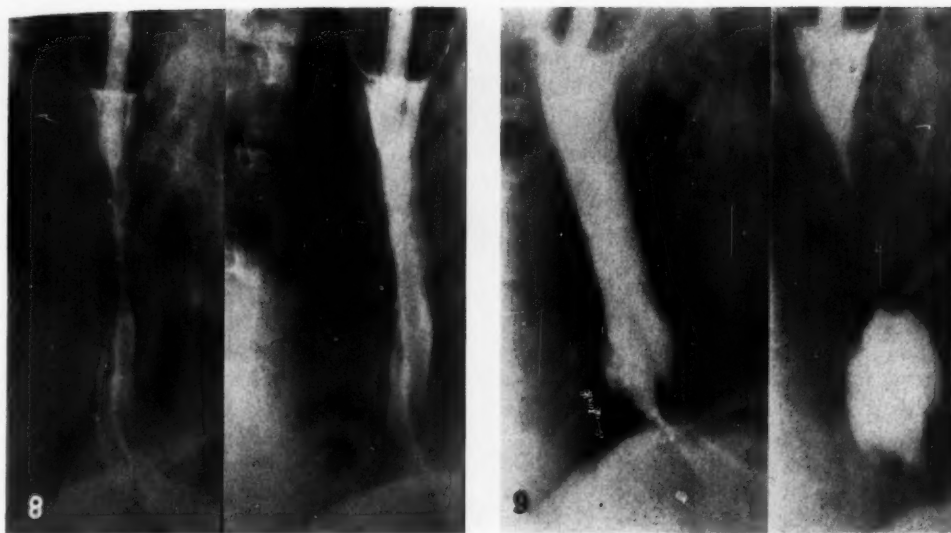
#### DISCUSSION

Results of this new method of examination of the esophagus—the balloon technic—indicate that it provides increased accuracy in determining the presence or absence of esophageal varices. No false positives were obtained and as yet there have been no proved false negatives. There were no complications in 27 examinations done on 24 patients. No increase in esophageal bleeding occurred. Most of the patients vomited during the passage of the distal end of the tube through the oropharynx and hypopharynx. Passage of the tube through the nose instead of the mouth has been employed recently and has proved to be a very effective factor in preventing this difficulty.

#### CONCLUSION

1. Esophageal varices have proved to be elusive for the radiologist, and the infre-





Figs. 8 and 9. Case III: Esophageal varices easily demonstrable when the "balloon" technic is used.

quency of positive radiological diagnoses in their presence has been disappointing.

2. A new method, employing compression of the esophageal walls by an inflated balloon, has improved the radiologic demonstration of esophageal varices and has proved of value not only in establishing a positive diagnosis but also in excluding the presence of varices which may be suspected from the conventional x-ray examination.

3. The accuracy of this new approach as compared to esophagoscopy remains to be evaluated.

Gerald Champion Memorial Hospital  
Alamogordo, N. M.

#### REFERENCES

- HIGGINS, W. H., JR.: Esophageal Varix; A Report of 115 Cases. *Am. J. M. Sc.* **214**: 436-441, October 1947.
- BLAKEMORE, A. H.: Portacaval Anastomosis. *Surg., Gynec. & Obst.* **87**: 277-279, September 1948.
- PALMER, E. D.: The Esophagus and Its Diseases. New York, Paul B. Hoeber, Inc., 1952, pp. 469-501.
- SENGSTAKEN, R. W., AND BLAKEMORE, A. H.: Balloon Tamponade for the Control of Hemorrhage from Esophageal Varices. *Ann. Surg.* **131**: 781-789, May 1950.
- KIRSH, I. E., BLACKWELL, C. C., AND BENNETT, H. D.: Roentgen Diagnosis of Esophageal Varices. Comparison of Roentgen and Esophagoscopy Findings in 502 Cases. *Am. J. Roentgenol.* **74**: 477-485, September 1955.
- SCHINDLER, R.: Safe Diagnostic Optical Esophagoscope. *J.A.M.A.* **138**: 885-887, Nov. 20, 1948.
- FIGLEY, M. M., FRY, W. J., OREBAUGH, J. E., AND POLLARD, H. M.: Percutaneous Splenopography. *Gastroenterology* **28**: 153-162, February 1955.
- HARE, H. F., SILVEUS, E., AND RUOFF, F. A.: Esophageal and Gastric Varices, with Report of Case. *S. Clin. North America* **28**: 729-732, June 1948.
- SCHATZKI, R.: Roentgen Demonstration of Esophageal Varices; Its Clinical Importance. *Arch. Surg.* **41**: 1084-1100, November 1949.
- BRICK, I. B., AND PALMER, E. D.: Comparison of Esophagoscopy and Roentgenologic Diagnosis of Esophageal Varices in Cirrhosis of Liver. *Am. J. Roentgenol.* **73**: 387-389, March 1955.
- BUTLER, H.: Veins of Esophagus. *Thorax* **6**: 276-296, September 1951.
- PATTERSON, C. O.: Discussion of Paper by Tocantins, L. M.: The Hemorrhagic Tendency in Congestive Splenomegaly (Banti's Syndrome). Its Mechanism and Management. *J.A.M.A.* **136**: 616-621, Feb. 28, 1948.
- KINSELLA, T. J., MORSE, R. W., AND HERTZOG, A. J.: Spontaneous Rupture of the Esophagus. *J. Thoracic Surg.* **17**: 613-631, October 1948.

(Pro le summario in interlingua, vider le pagina sequente)

## SUMMARIO IN INTERLINGUA

**Diagnose de Varices Esophagee per Medio de un Nove Methodo Radiologic: Reporto Preliminari**

Le effectuation de un prophylactic operation chirurgic in casos de varice esophagee ha como prerequisite un precoce diagnose que precede omne episodio de sanguination. Un tal diagnose depende in alte mesura del radiologo, proque le facto que le esophagoscopista es capace a provider un plus alte grado de accuratia diagnostic es frequentemente sin importantia practic a causa del hesitantia del parte del medico e del paciente de acceptar ille forma de examine.

Es describe un nove methodo de diagnose radiologic in que compression del parietes esophagee es effectuate per medio

de un ballon introduce in le passage esophagee e distendite con aere. Iste methodo esseva usate in 24 pacientes. Le presentia de varices esseva subsequeamente demonstrate chirurgica- o esophagoscopicamente in 5 casos; lor absentia esseva similamente demonstrate in 5 altere casos; le remanente 14 casos non esseva operate e non esseva tenite sub observation.

Le valor del examine jace non solmente in le demonstration de varices sed etiam in le demonstration de lor absentia in casos in que studios conventional supporta ille diagnose erroneemente.



So

T  
ven  
aort  
tion  
phy  
limi  
of m  
inte  
are  
the

W  
ima  
fact  
of t  
dian  
gain  
aver  
darl  
used  
pho  
hea  
rect  
puls  
for  
phy  
exp  
dep  
mov  
x-ra  
film  
for  
to t  
phra  
the  
the  
x-ra  
F  
spee

<sup>1</sup> P  
partn  
cation  
<sup>2</sup> P  
using

## Some Uses of Cinefluorography in Urologic Diagnostic Problems<sup>1</sup>

WILLIAM N. HANAFEE, M.D., and RODERICK D. TURNER, M.D.

THE ANATOMICAL details of the urinary system may be investigated by intravenous urography, retrograde urography, aortography, retroperitoneal air insufflation, etc. Studies of the pathological physiology of the urinary tract have been limited by lack of a modality for the study of motion. Recently, however, the image intensifiers with attached movie cameras are allowing a more complete appraisal of the functioning urinary system.

### EQUIPMENT

We are using a commercially available image intensifier and camera unit manufactured by Westinghouse. The field size of the intensification tube is limited to a diameter of 4.5 inches. An illumination gain approximately 400 times that of the average fluoroscopic screen is possible, but dark-adaptation principles should still be used for proper selection of the areas for photographing. The x-ray source is a heavy-duty Dynamax tube with full-wave rectification for fluoroscopy so that 120 pulses per second of x-ray are available for visualization. During cinefluorography, the tube is energized only during film exposure. The camera has no shutter and depends on synchronization of the film movement with de-energization of the x-ray tube. The tube shuts off as each film frame advances, being thus shut off for half the filming time, reducing exposure to the patient accordingly. An iris diaphragm is not needed in the camera, since the amount of radiation (and therefore the amount of light) is a function of the x-ray tube milliamperage.

Film selection cannot be based on the speed as given by the conventional A.S.A.

rating, as this is based on blackening of the film after exposure to white light, which is a combination of all the colors of the spectrum. All films are inherently sensitive to blue light, while others have been processed to be sensitive in the opposite end of the spectrum, within the red range. In cinefluorography we are actually photographing a fluorescent screen. Two main wave lengths of light come from the fluorescent surface of our intensification tube. One peak is at 4,900 Å.; the major peak is at 5,700 Å. The combined effect is a yellow-green light. In choosing films, Shellburst, for example, is an extremely sensitive film developed to photograph the red flashes of shells from night fighter planes. Since no red light comes from our intensification tube, red-sensitive film is of no value. To date, no film has been developed specifically for cinefluorography.<sup>2</sup>

After considerable searching we have found that Dupont 931A reversal film gives us maximum speed and the greatest number of gray tones with tolerable grain size. Graininess is not as critical in cinefluorography as in still photography. In illustrations made from single frames or single-frame viewing in an "analyst type" of projector, a coarse grain is objectionable. When, however, the film is being viewed as a movie, there is no superimposition of individual grains and this objection disappears.

A long gray scale is necessary to differentiate structures of similar densities. A good example is the contrast between an opaque calculus in a renal pelvis filled with a radiopaque medium. All of our processing is done in a commercial photography laboratory. Our reversal film is

<sup>1</sup> From the University of California School of Medicine, Los Angeles, Calif. (W. N. H., Assistant Professor, Department of Radiology; R. D. T., Assistant Professor, Department of Surgery-Urology). Accepted for publication in November 1958.

<sup>2</sup> Eastman Kodak Co. has recently marketed "Cineflure" specifically for cinefluorography, which we are now using.

developed as reversal, and prints are made either to maintain or build up contrast as desired for the specific examination.<sup>3</sup>

Movies may be taken at either 15 or 30 frames per second depending on the area being radiographed. Most of our bladder studies are done at 30 frames per second in order to obtain the maximum number of views of rapidly transpiring events. Studies of an ileal ureter or pelvocalyceal system, where events take place at a slower pace, are generally done at 15 frames per second.

A typical example of our technic is il-

In this instance it was 70 kv. The image intensifier and camera were then positioned fluoroscopically over the area to be examined and a three-second exposure was made. The milliamperage was then adjusted to give a photocell reading of 12 to 15. In this instance 8 ma was chosen.

Patient exposure can be maintained at reasonable levels by the above method. Calculation of the skin dosage is made according to the graph in Figure 1. For two minutes of movie film in this case, patient exposure is comparable to that in a gastrointestinal series. We attempt to

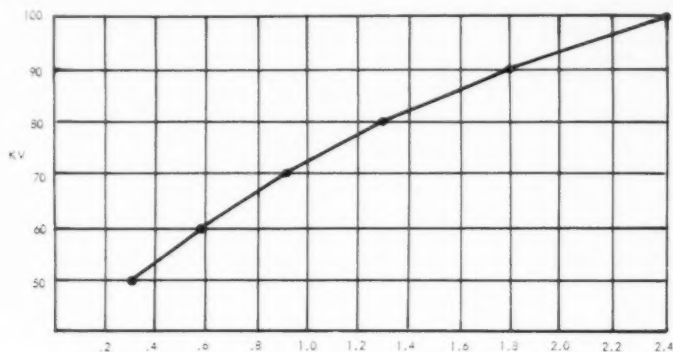


Fig. 1. Roentgens per minute per milliampere delivered to the skin with a  $5 \times 5$ -inch field. An approximate error of 10 per cent is inherent in the system. Most of the authors' urological cinefluorographic work is done at 6 ma or 11 ma, at 15 frames per second.

lustrated by the following case: N. B., a white female, 5 feet, 3 inches in height, weighing 118 pounds, was referred for retrograde filling and voiding cystograms. An ileocystoplasty by which the contracted urinary bladder was enlarged with an isolated ileal segment had been performed one month prior to this examination. Before the instillation of contrast material, a selection of kilovoltage and milliamperage was made. Our equipment has a photo cell just in front of the camera that tells how much light is striking the film. By experience, we know that a reading of 12 to 15 on the photo cell indicates satisfactory exposure of the movie film.

The kilovoltage will be practically the same as for other radiographic procedures.

<sup>3</sup> By a homemade adaptive device we now process our own film through the Eastman X-Omat.

maintain roentgen exposures to the skin below 25 r except under unusual circumstances. A lead scrotum protector is used in males whenever possible.

#### APPLICATIONS

Abnormalities involving neurogenic disturbances or altered structural physiology are especially adaptable to cinefluorography. Pediatric patients with pseudo-residual urine are particularly interesting subjects.

One of our early patients, G. H., a seven-year-old-boy, was referred for a repeat transurethral resection because of bladder neck obstruction and residual urine. Marked bilateral hydronephrosis and hydroureters were already present on admission. Postvoiding catheterization revealed residual urine volumes ranging from

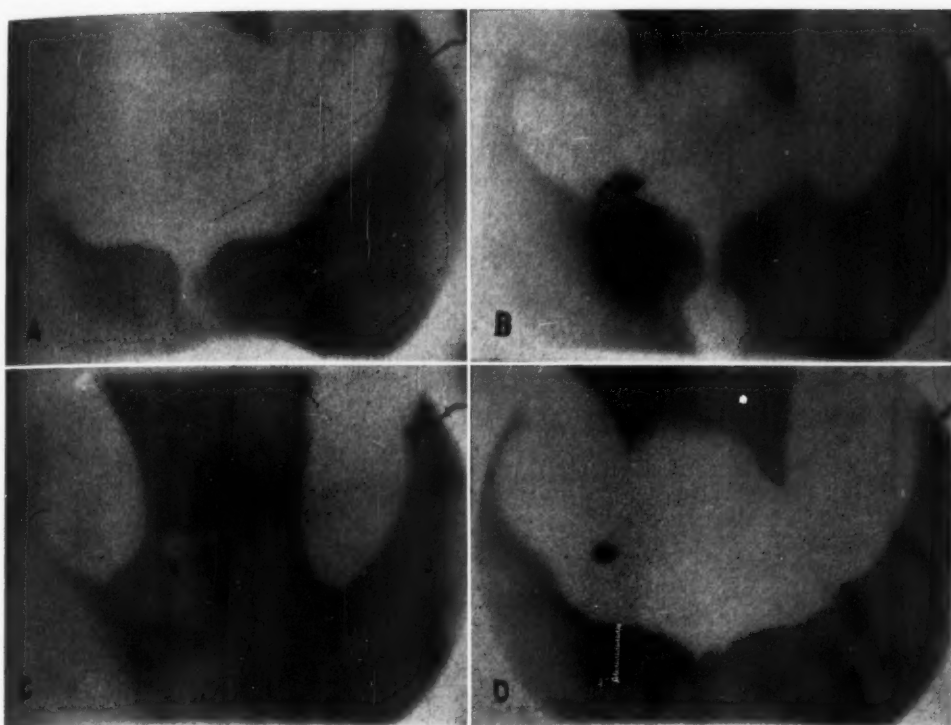


Fig. 2. A seven-year-old child with bilateral hydronephrosis was believed to have vesical neck obstruction because of residual urine on catheterization. Figures A, B, and C show the bladder contracting with urine passing through an entirely adequate vesical neck. A portion of the contrast material also enters the ureters. Figure D shows the bladder filling from the ureters after it had completely emptied. This event could be viewed five times in succession before termination of micturition.

60 to 120 c.c. Even on the cystoscopy table 100 c.c. of urine were obtained by catheterization immediately after voiding. Cinefluorography was performed during instillation of 120 c.c. of 30 per cent Hypaque into the bladder, showing immediate reflux into both ureters and renal pelves. The child was requested to void while a movie was being taken (Fig. 2). During bladder contraction approximately one-half of the contrast material passed out of the anterior urethra, with reflux of the remainder into the dilated ureters and kidneys. The ureteral walls appeared to relax and act as a urinary reservoir. The bladder emptied completely and, upon relaxation of the ureterovesical junction, contrast material again filled the bladder from the ureters. Ureteral peristalsis was very active following bladder relaxation.

The voiding act was repeated four times and still a large amount of contrast material remained in the ureters. On none of the studies was any residual urine noted in the bladder. The time interval between completion of the act of voiding, promptly getting onto the cystoscopic table, and urethral catheterization, was long enough to allow refilling of the bladder from the dilated kidneys and ureters, resulting in a pseudo-residual urine. This erroneous impression was demonstrated clearly by cineradiography. Since there was no bladder neck obstruction, transurethral resection was not indicated. Our findings are identical with those reported by Edwards.

Roentgen evaluation of the uretero-ileo-cutaneous anastomosis, or Bricker urinary diversion, is virtually impossible without



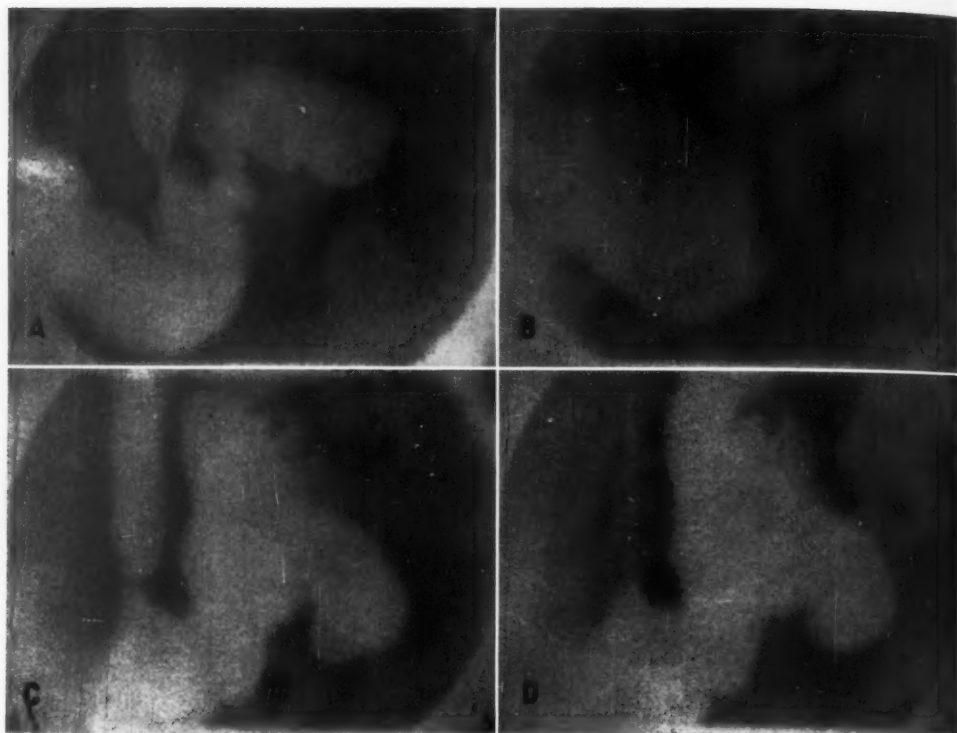


Fig. 3. Postoperative Bricker urinary diversion. The patient complained of persistent right flank pain. A and B show reflux into the right ureter as peristalsis proceeds along the isolated ileal segment. After the contraction wave has passed, the ureter empties well. Some reflux is also present on the left, but to a lesser extent. When distention of the right collecting system occurred, the symptoms were reproduced.

fluoroscopy or a record of peristaltic activity.

Patient D. M. was operated upon for total urinary incontinence, with substitution of an isolated ileal segment for a urinary conduit. After removal of the bladder, the ureters were anastomosed to the ileal segment and its distal end was brought out through the skin (as an ileostomy) in the right lower abdominal quadrant in an isoperistaltic direction. Postoperatively, the patient complained of dull, almost constant pain in the right costovertebral angle and right flank. An intravenous urogram showed slight dilatation of the right ureter, possibly on the basis of infection or stricture. Cinefluorography following retrograde injection of the isolated ileal segment showed prompt reflux up the right ureter (Fig. 3). Some reflux was present on the left but not as im-

mediate or extensive as on the right. As peristaltic activity increased in the isolated ileal segment, a churning action could be seen taking place between the ileal segment and the right ureter. As a peristaltic wave passed along the ileal loop, contrast material was forced into the more distally anastomosed right ureter but not into the left ureter. As the bowel segment relaxed, the contrast material drained from the right ureter and again entered the ileal segment. These observations were confirmed by intravenous injection of 60 c.c. of Hypaque and cinefluoroscopy. Because of them the patient was operated upon; the right ureter was re-implanted into the proximal end of the isolated ileal segment. Without cinefluoroscopy the relationship between ileal peristalsis and right ureteral reflux could not have been appreciated.

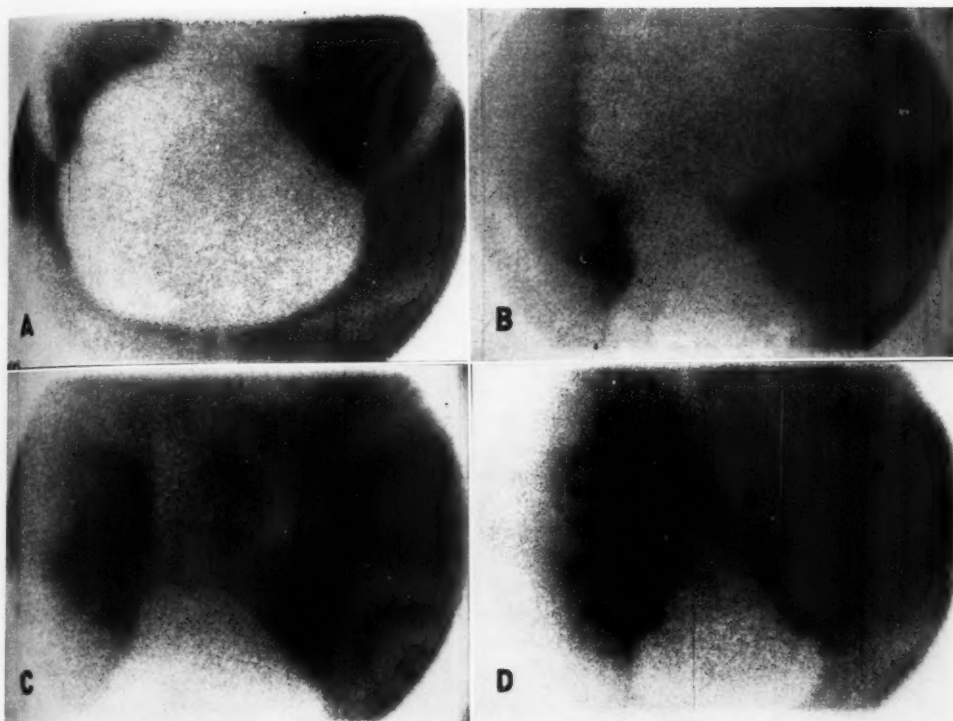


Fig. 4. An isolated segment of ileum was opened along the antimesenteric border and anastomosed to the dome of the bladder to increase bladder capacity. A shows the filled bladder and B the ileal patch. (The limited diameter of the amplifier prevented us from viewing both on the same frame.) Reflux into the ureters is noted only in the initial phase of the examination. Figures C and D are frames taken during the act of voiding. The ileal patch empties first and completely. The diseased bladder retains 15 to 20 c.c. of contrast material.

In any operation where one organ is substituted for another, one must decide whether or not the substituted organ can actually perform the alien function of its new assignment. The following case is a good example of the necessity of such decision.

N. B. was a 43-year-old female with chronic interstitial cystitis of eighteen years duration. She had a bladder capacity of 30 to 35 c.c. Her frequency was so great that she was unable to leave her home even for ordinary shopping requirements. An ileocystoplasty was performed by isolating a segment of terminal ileum and forming a cup or dome-shaped patch (Goodwin, Turner, and Winter), after incising the antimesenteric margin longitudinally. The isolated ileal patch was anastomosed to the dome of the bladder.

The bladder capacity was thus increased to 800 c.c. Postvoiding catheterization revealed some residual urine. Evaluation of postoperative function of the isolated ileal segment was carried out. A cinefluorographic cystogram showed that first of all the original bladder filled and then the anastomosed ileal segment. During voiding, the reverse sequence occurred—the ileal cup emptied first, and the remaining pathological bladder emptied poorly. The residual urine was shown to be actually in the diseased bladder with the ileum completely empty. This single case would indicate that a more extensive removal of the diseased bladder would cut down the postoperative residual urine.

In general, we get more information from sources exposed for one or two minutes without interruption or panning. Lesser

runs do not allow complete observation of the variations that take place between successive peristaltic waves.

Up to the present time our observations are only gross in detail. We are able to see everything on the intensifying screen that we can document on film. Film has the obvious advantage of affording a permanent record for future comparison. Its teaching use is invaluable. Technics used for viewing movies may be almost as important as the making of the film. For careful analysis of a physiological process, one may make a "loop" of the film and project the same event over and over again. If details of a single frame are to be studied, a projector that can be stopped without burning the film is essential.

The future importance of cineradiography lies in further refinement of film and camera equipment, so that, as with conventional radiographic equipment, one is able to record on film the fine detail not visible fluoroscopically. The film should perform a similar function as spot films taken during fluoroscopy of the gastrointestinal tract.

We have been sufficiently encouraged to restudy more common abnormalities to broaden, if possible, our understanding of pathological physiology and therapeutic results.

#### CONCLUSIONS

Cinefluoroscopy has made it possible to record pathological physiologic changes that could not be diagnosed with conventional films. Ureteral reflux, isolated ileal segments of the Bricker operation, and ileocystoplasty are especially suitable for cinefluoroscopic investigation.

Many hydronephrotic changes ordinarily attributed to scarring and mechanical obstruction are in reality disturbances in bladder contraction and sphincter mechanisms.

Diagnostic cinefluorograms can be obtained with exposure levels not in excess of conventional fluoroscopic procedures.

University of California Medical Center  
Los Angeles 24, Calif.

#### REFERENCES

- ALLCOCK, J., AND BERRIDGE, F. R.: Clinical Applications of Image Intensification; Some Applications of Cinematography to the Radiology of the Esophagus. *Brit. J. Radiol.* **29**: 560-562, October 1956.
- ARDRAN, G. M., AND KEMP, F. H.: Radiologic Investigation of Pharyngeal and Laryngeal Palsy. *Acta radiol.* **46**: 446-455, August 1956.
- ARDRAN, G. M., KEMP, F. H., AND WEGELIUS, C.: Swallowing Defects after Poliomyelitis. *Brit. J. Radiol.* **30**: 169-189, April 1957.
- ARDRAN, G. M., KEMP, F. H., AND LIND, J.: A Cineradiographic Study of Bottle Feeding. *Brit. J. Radiol.* **31**: 11-23, January 1958.
- ASTLEY, R., AND OLDHAM, J. S.: Cineangiography. *Brit. J. Radiol.* **29**: 556-560, October 1956.
- BARCLAY, A. E., FRANKLIN, K. J., AND PRICHARD, M.: X-ray Cinematography in Research. *Brit. J. Radiol.* **13**: 227-234, July 1940.
- BENJAMIN, J. A., ET AL.: Cinefluorographic Studies of Bladder and Urethral Function. *J. Urol.* **73**: 525-535, March 1955.
- BENJAMIN, J. A., JOINT, F. T., RAMSAY, G. H., WATSON, J. S., WEINBERG, S. A., AND SCOTT, W. W.: Cinefluorographic Studies of Bladder and Urethral Junction. *Tr. Am. A. Genito-Urin. Surgeons* **46**: 43-53, 1954.
- BODNER, H., HOWARD, A. H., AND KAPLAN, J. H.: Cinefluorography for the Urologist. *J. Urol.* **79**: 356-362, February 1958.
- BOISSONNAT, P.: Radio-cinematographie de la miction. *J. urol. méd. et chir.* **61**: 412-414, 1955.
- BOSMA, J. F.: Studies of Disability of the Pharynx Resultant from Poliomyelitis. *Ann. Otol., Rhin. & Laryng.* **62**: 529-547, June 1953.
- CAULK, J. R.: Megaloureter; Importance of Uretero-Vesical Valve. *J. Urol.* **9**: 315-330, November 1923.
- CRICHLAW, T. V. L.: Clinical Applications of Image Intensification; Cricopharyngeus in Radiography and Cineradiography. *Brit. J. Radiol.* **29**: 546-556, October 1956.
- DE CASTRO, J. M.: Fundamental Principles in the Application of Cineradiography as an Auxiliary Method to Roentgen Diagnosis. *Am. J. Roentgenol.* **57**: 103-114, January 1947.
- EDWARDS, D.: Cine-radiology of Congenital Bladder-neck Obstruction and the Megaureter. *Brit. J. Urol.* **29**: 410-415, December 1957.
- FISHER, O. D., AND FORSYTHE, W. I.: Micturating Cysto-Urethrography in Investigation of Enuresis. *Arch. Dis. Childhood* **29**: 460-471, October 1954.
- GOODWIN, W. E., TURNER, R. D., AND WINTER, C. C.: Results of Ileocystoplasty. *J. Urol.* **80**: 461-466, December 1958.
- GREENWOOD, F. G.: Cineradiography in Urinary Tuberculosis. *Brit. J. Radiol.* **30**: 493-496, September 1957.
- GREENWOOD, F. G.: The Clinical Applications of Image Intensification. I. Cineradiography as a Routine Procedure. *Brit. J. Radiol.* **29**: 544-545, October 1956.
- HANLEY, H.: The Use of the X-ray Image Amplifier in Renal Tuberculosis. *Brit. J. Urol.* **29**: 312-314, September 1957.
- HOLMGREN, B. S.: Roentgen Cinematography as a Routine Method. *Acta radiol.* **26**: 286-292, March 1945.
- KAWAISHI, K.: Studies on Roentgen Cinematography of the Internal Organs and Circulation of the Blood of the Human Body. *Am. J. Roentgenol.* **40**: 913-921, December 1938.
- LUSTED, L. B., AND MILLER, E. R.: Progress in Indirect Cineradiography. *Am. J. Roentgenol.* **75**: 56-62, January 1956.

MORGAN, R. H.: Screen Intensification: A Review of Past and Present Research With an Analysis of Future Development. *Am. J. Roentgenol.* **75**: 69-76, January 1956.

ORMOND, J. K.: Megalo-Ureter and Related Conditions in Children; Report of Six Cases. *J. Urol.* **70**: 171-179, August 1953.

REYNOLDS, R. J.: Cineradiography. *Am. J. Roentgenol.* **33**: 522-528, April 1935.

ROBERTS, R. I.: A Cineradiographic Investigation of Pharyngeal Deglutition. *Brit. J. Radiol.* **30**: 449-460, September 1957.

STEWART, W. H., HOFFMAN, W. J., AND GHISELIN, E.

H.: Cinefluorography. *Am. J. Roentgenol.* **38**: 465-469, September 1937.

SWENSON, O.: New Concept of Pathology of Megaloureters. *Surgery* **30**: 367-371, August 1952.

WATSON, J. S., JR., AND WEINBERG, S.: A 35-mm. Unit For Cinefluorography. *Radiology* **51**: 728-732, November 1948.

WEINBERG, S. A., WATSON, J. S., AND RAMSEY, G. H.: Cinefluorography; Technical Refinements. *Am. J. Roentgenol.* **75**: 63-68, January 1956.

WILLIAMS, D. I.: Chronically Dilated Ureter. Hunterian Lecture. *Ann. Roy. Coll. Surgeons England* **14**: 107-123, February 1954.

#### SUMMARIO IN INTERLINGUA

##### Alicun Usos de Cinefluorographia in Problemas del Diagnose Urologic

Le cinefluoroscopia ha rendite possibile registrar alterationes pathophysiologic que non esserea diagnosticabile con pelliculas conventional. Refluxo ureteral, isolate segmentos ileal del operation de Bricker, e ileocystoplastia es specialmente appropriate como objectos de investigationes cinefluoroscopic.

Multe alterationes hydronephrotic que es ordinarimente attribuite a cicatrization

e obstruction mechanic es recognoscite como realmente effectos de un disturbance del contraction del vesica e del mecanismos de sphinctere. Studios de pacientes pediatric con urina pseudoresidue es specialmente interessante.

Cinefluorogrammas diagnostic pote esser effectuate a nivellos de exposition non excedente le nivellos requirite in le fluoroscopia conventional.



## Some Basic Principles in the Diagnosis of Chest Diseases<sup>1</sup>

BENJAMIN FELSON, M.D.,<sup>2</sup> Moderator; FELIX G. FLEISCHNER, M.D.,<sup>3</sup> JOHN R. McDONALD, M.D.,<sup>1</sup> and COLEMAN B. RABIN, M.D.,<sup>5</sup> Panelists

### INTRODUCTION

DR. FELSON: The experts on this panel have been selected because of their deep interest and outstanding contributions in the field of chest roentgenology. They will present their points of view on certain fundamental problems which are encountered in the interpretation of chest roentgenograms.

As to the technic of this exercise, we are going to do something different. This is not a film-reading session, a guessing game in which the cases are presented as unknowns to the panelists. Instead, I will present cases which illustrate one of the topics chosen for discussion. I will point out the salient roentgen features and give the diagnosis. Then I will ask specific questions related to the subject illustrated. The case material has been selected to bring out certain basic concepts and the questions I will ask, for the most part, will express my own uncertainties.

### CALCIFICATION IN "COIN" LESIONS

Figure 1 is a laminagram of a large nodule containing an eccentric calcification. Subsequent roentgenograms showed a gradual diminution in its size, and by the end of two years the nodule had disappeared, leaving a small scar. The patient had received no treatment. Figure 2 shows a small nodule with central calcification in a 45-year-old white male who was asymptomatic. During the two-and-a-half-year interval between A and B the nodule more than doubled in size. It was resected and found to be a granuloma. *Histoplasma capsulatum* was demonstrated on direct smear. Figure 3



Fig. 1. Laminagram of large nodule, showing calcification. The lesion subsequently disappeared spontaneously.

shows a primary carcinoma which engulfed a pre-existing pulmonary calcification.

Dr. Rabin, if you had a "coin" lesion containing calcium in your own chest, would you have it resected?

DR. RABIN: That would depend on its roentgen appearance. If there were a large central calcification or a concentric calcified ring I would not be operated upon because there is no tendency for that type of lesion to spread. However, if there were a small central calcification with considerable noncalcified tissue about it and evidence of growth on subsequent films, I would have it resected because some of these lesions are *actively* inflammatory in nature. In the first case you showed (Fig. 1) I believe resection should have been performed initially, even though the lesion

<sup>1</sup> Presented as a Panel at the Forty-fourth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 16-21, 1958.

<sup>2</sup> Professor and Director, Department of Radiology, University of Cincinnati College of Medicine.

<sup>3</sup> Clinical Professor of Radiology, Harvard Medical School, and Director, Department of Radiology, Beth Israel Hospital, Boston, Mass.

<sup>4</sup> Director, Department of Laboratory and Research, Harper Hospital, Detroit, Mich.

<sup>5</sup> Attending Physician for Chest Diseases and Associate Radiologist, Mt. Sinai Hospital, New York, N. Y.



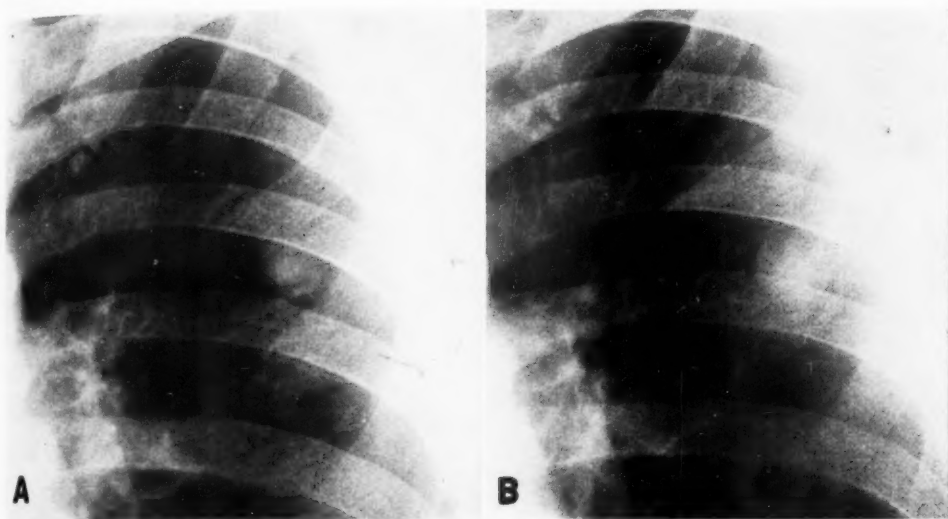


Fig. 2. A. Proved histoplasmosis with concentric central calcification.  
B. Appearance two and a half years later. The nodule is distinctly larger. (Courtesy Drs. Lee S. Rosenberg and Henry Felson.)

subsequently disappeared. I think it represented a blocked tuberculous cavity and the patient would have been better off without it.

DR. FELSON: Have you personally seen a primary malignant lung nodule which contained calcium?

DR. RABIN: Yes. One should be certain, of course, that the calcium is within the nodule because, on a single film, calcium behind or in front of the lesion may appear to lie within it. A malignant tumor may engulf an earlier calcium deposit, as you have shown (Fig. 3). This can be suspected if one or more small calcific deposits are seen near the periphery of the nodule.

I have seen three cases of primary carcinoma of the lung which contained calcium. In one, it was apparent from previous films that the carcinoma had grown around a pre-existing calcium fragment. In addition to these three cases, I have seen two others which seemed, on the film, to contain calcium, but none was found in the resected specimen. Incidentally, I have also seen peripheral calcification in a blocked cavity.

DR. FELSON: Dr. McDonald, what is the nature of the calcification within



Fig. 3. Primary carcinoma of the lung. The calcification was present on an earlier film, prior to the appearance of the tumor.

these lung nodules? How does it get there?

DR. McDONALD: Just what gives rise to calcification in lung lesions is not too



Fig. 4. Cavitated metastatic tumor.

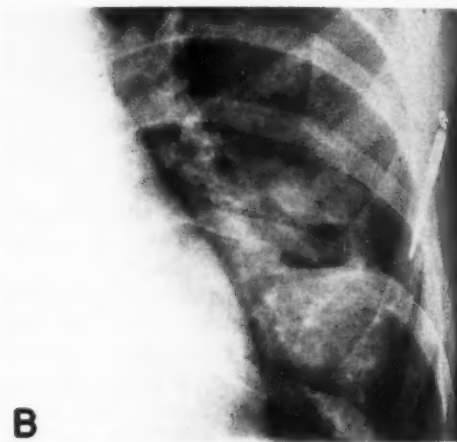
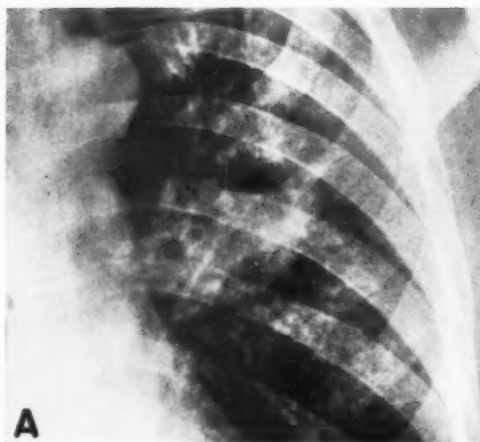


Fig. 5. Two cases of cavitated bronchogenic carcinoma.

well known. Calcium may be deposited in the necrotic areas within granulomas or malignant tumors. It probably has something to do with the pH of the tissues. Calcium may also be deposited in a cartilage-containing lesion. It is often found in the lungs in hyperparathyroidism and in other conditions associated with elevated blood calcium levels, but it is probably not demonstrable on the chest film.

#### CAVITATION WITHIN "COIN" LESIONS

DR. FELSON: Figure 4 demonstrates cavitation in a solitary metastasis from

a primary carcinoma of the pharynx. Figure 5 illustrates two cases of cavitated bronchogenic carcinoma. Figure 6 shows a series of films on a patient who ultimately proved to have a primary squamous-cell carcinoma of the lung. On the very first film cavitation was present, the cavity subsequently growing in size as the lesion enlarged.

Dr. McDonald, are there any characteristics of a cavity that should suggest that it is cancerous? I am not speaking of the abscess distal to an obstructing carcinoma, but of cavitation within the tumor itself.

DR. McDONALD: Cancer is suggested if the wall of the cavity is thick and the lining irregular and shaggy. Squamous carci-

noma is essentially the only type of primary cancer of the lung in which central cavitation develops. Occasionally cavitation will occur in metastatic carcinoma or sarcoma.

I would like to decry the use of the term, *outgrowing its blood supply*, since that is not the principal cause of cavitation within nodular carcinoma. In primary cavity carcinoma, tumor cells line the cavity and there is no central necrosis. The last case (Fig. 6) is surely an example of this.

DR. RABIN: In a good many cases it is impossible to make the diagnosis of cancer from the roentgen appearance of the cavi-

tion.  
for a  
the th  
come  
made.

DR.  
have s  
with p  
carcin

DR.  
four  
carcin

DR.  
wrong  
cavita  
be dia  
have s  
canno  
graph  
that t  
good i

DR.

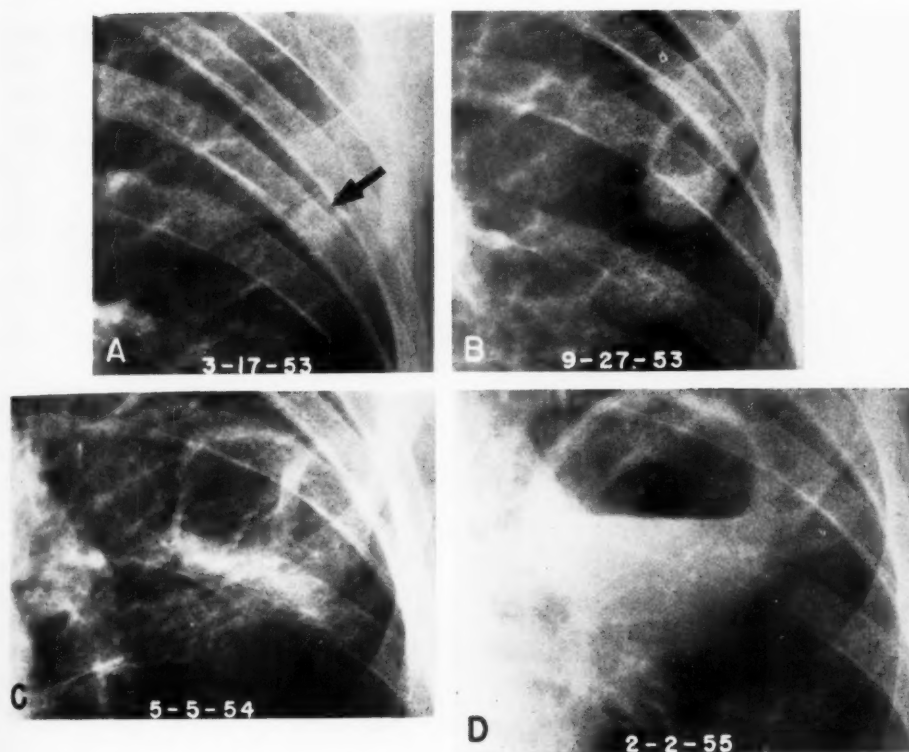


Fig. 6. Squamous carcinoma of the lung. The cavity was already present on the first film.

tion. However, if such cases are followed for a comparatively short period of time, the thick wall already mentioned will become evident and the diagnosis can be made.

DR. FLEISCHNER: On the contrary, I have seen at least two examples of a cavity with paper-thin walls which proved to be carcinoma.

DR. FELSON: I have also seen three or four cases of this type, all squamous carcinomas.

DR. RABIN: I am afraid I gave the wrong impression. There are cases of cavitary carcinoma which cannot possibly be diagnosed roentgenographically. I, too, have seen thin-walled carcinomas, but one cannot make the diagnosis roentgenographically in this type of lesion. I agree that the thick, irregular-walled cavity is a good indication of malignancy.

DR. FELSON: I would like to add that, if

the cavity within the nodule is eccentric or if more than one cavity is seen, cancer is an excellent possibility. The same is true if a thin-walled cavity slowly enlarges.

Before leaving the subject of the "coin" lesion I want to mention the notch or indentation sometimes seen on the outer surface of such lesions, as described by Dr. Rigler (1). I do not consider it pathognomonic of malignancy since the first two cases we encountered after Dr. Rigler's report appeared turned out to be granulomas.

#### KERLEY'S B LINES

Figure 7 is a classical example of Kerley's B lines (2) in a patient in mild heart failure. He did not have mitral stenosis. We have also seen these lines in patients with lymphangitic metastases, pneumoconiosis, and scleroderma. Dr. Fleischner, what is the nature of these lines? In what other conditions are they encountered?



Fig. 7. Kerley's B lines in a patient with hypertensive heart disease in mild failure.

DR. FLEISCHNER: We have been convinced for some time that they correspond to the interlobular septa, made visible by certain disease processes. This has been substantiated by the pathological studies of Professor Gough of Cardiff (3). They

are properly called septal lines and are commonly encountered in mitral valvular disease and other cardiac conditions. If they are constant and unchanging in appearance, they indicate the deposition of hemosiderin along the interlobular septa; if they are transient or rapidly change in number or width, they indicate interstitial edema in the areolar tissue of the septa. Dilated lymph vessels play a negligible role in their formation.

The interlobular septa may also become visible through the deposition of dust, as in workers exposed to tin oxide, certain iron ores, hematite, fluorides, and other relatively inert dusts. If fibrosis supervenes, as in silicosis and interstitial pneumonia, the lines may appear even more striking. In lymphangitic metastases the pathogenesis of the septal lines is related to carcinomatous thrombi in the lymph vessels, interfering with lymph flow.

DR. FELSON: Do you feel that there is any relationship between these lines and pulmonary venous hypertension in mitral stenosis?

DR. FLEISCHNER: There has been quite a bit of confusion in this respect. It is now more or less generally recognized that increased pulmonary venous pressure, as it occurs in mitral lesions and in left ventric-

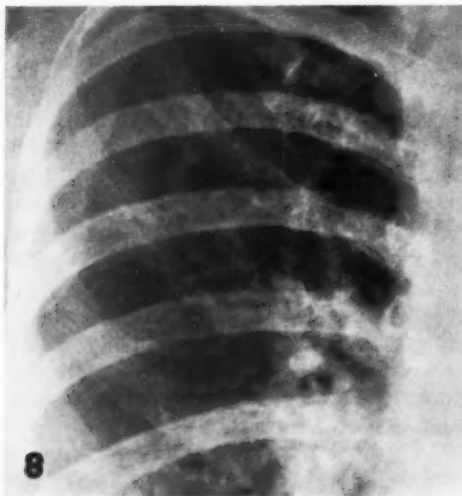


Fig. 8. Segment of right lung in a patient with mitral valve disease, showing dilated pulmonary veins.

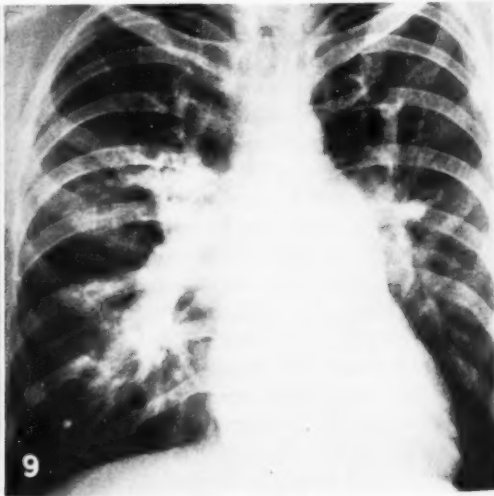


Fig. 9. Atrial septal defect with marked dilatation of the pulmonary arteries.

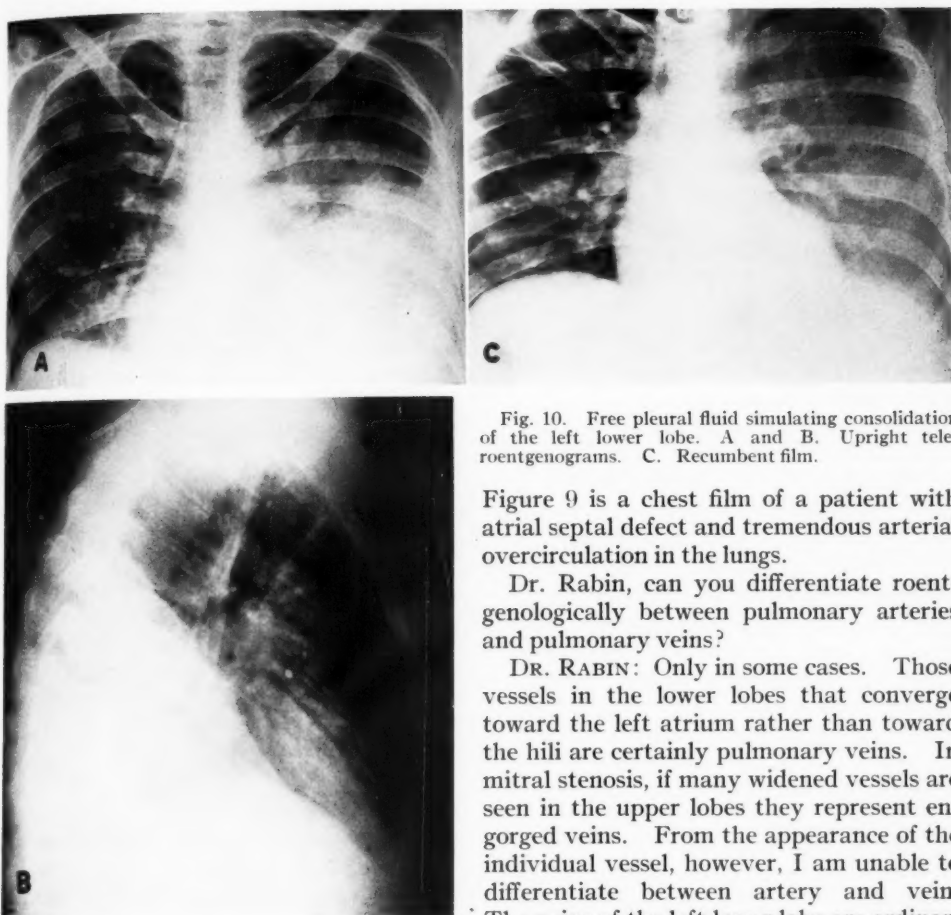


Fig. 10. Free pleural fluid simulating consolidation of the left lower lobe. A and B. Upright tele-roentgenograms. C. Recumbent film.

Figure 9 is a chest film of a patient with atrial septal defect and tremendous arterial overcirculation in the lungs.

Dr. Rabin, can you differentiate roentgenologically between pulmonary arteries and pulmonary veins?

DR. RABIN: Only in some cases. Those vessels in the lower lobes that converge toward the left atrium rather than toward the hili are certainly pulmonary veins. In mitral stenosis, if many widened vessels are seen in the upper lobes they represent engorged veins. From the appearance of the individual vessel, however, I am unable to differentiate between artery and vein. The veins of the left lower lobe are ordinarily obscured by the heart shadow.

DR. FELSON: Have you been able to recognize the so-called ischemic area of pulmonary embolism?

DR. RABIN: Although I have frequently looked for it, I have found it only rarely. Theoretically, it should occur more often than it does.

DR. FELSON: How reliable is the roentgen evaluation of pulmonary artery undercirculation?

DR. RABIN: The normal variation of the pulmonary vessels is so great that, unless the changes are extreme, the diagnosis of undercirculation is not reliable.

DR. FELSON: Dr. Dolores Arnois gave me the acid test (6). She tested three radiologists with a number of chest films

ular failure, is an important factor in the causation of pulmonary edema. Therefore, it should correlate well with septal edema. In these cases the clinician does not hear much on auscultation because the edema is interstitial, so that it is important to call his attention to the septal lines as a sign of borderline decompensation.

#### THE INTRAPULMONARY VESSELS

DR. FELSON: Figure 8 illustrates venous engorgement in a patient with mitral stenosis and insufficiency. There were dilated pulmonary veins in the upper lobes and decreased vascularity in the lower lobes, a combination reported to signify pulmonary venous hypertension (4, 5).



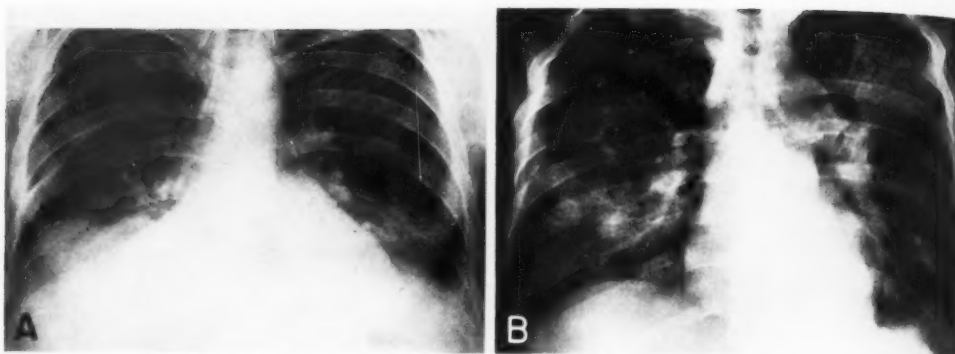


Fig. 11. Free pleural fluid simulating cardiac enlargement. A. Upright teleroentgenogram. B. Recumbent film (same day).

covered with black paper except for the peripheral three-fourths of the right lung. We were asked to record whether the arterial circulation was increased, normal, or decreased. We did extremely well on the cases with arterial overcirculation but our accuracy was poor in differentiating decreased from normal arterial circulation.

#### PLEURAL FLUID

DR. FELSON: Figure 10, A and B, shows an extensive density occupying the position of the left lower lobe. This was interpreted as consolidation. However, the recumbent film (Fig. 10, C) proves that it was all free fluid. In Figure 11, A, the heart appears to be extremely large and I made a diagnosis of congestive failure. I should have noted that the pulmonary vessels were not engorged. The recumbent film (Fig 11, B) revealed a normal heart and made it obvious that we were dealing with an unusual distribution of free pleural fluid. The patient had Hodgkin's disease.

We all see cases in which the distribution of free pleural fluid on the upright film is difficult to explain. The commonest of these atypical patterns is that of fluid trapped between the base of the lung and the upper surface of the diaphragm. Dr. Fleischner, what other unusual patterns of free pleural fluid have you encountered?

DR. FLEISCHNER: Free fluid may arrange itself about an individual lobe. It also

may collect along the mediastinal portion of the pleural cavity or even in pockets along the lateral chest wall. Extension into an interlobar fissure is not uncommon.

Subpulmonary effusion is quite common in congestive failure, the nephrotic syndrome, constrictive and exudative pericarditis, and in association with ascites. The subpulmonary localization has nothing to do with the constitution of the fluid. One should suspect subpulmonary fluid if one or both diaphragms appear to be unusually elevated; if the costophrenic angle is not clear, especially in the lateral or oblique view; if the distance between the gas shadow in the fundus of the stomach and the left diaphragm appears unduly wide; if the minor fissure lies unusually close to the dome of the right diaphragm.

Free fluid shows these unusual patterns because the lung is not a shapeless freely moldable mass. Even when the lung is removed from the chest it maintains its shape. In pneumothorax, although the lung retracts toward the hilus, where it is moored, it widens out inferiorly because it is heavier than the air in the pneumothorax. In pleural effusion the lung floats to some extent on the fluid but preserves its shape to a considerable degree. With pleural effusion portions of the lung may show an increased tendency to collapse because of multifocal partial obstructions within it. As the lung retracts, the negative pressure thus created attracts the fluid as in a

pocket. Since the relative retractive tendency of the individual lobes may vary from case to case, different roentgen patterns of free fluid may occur.

#### HONEYCOMB LUNG

DR. FELSON: Figure 12 is a close-up of a segment of the chest roentgenogram of a patient who had diffuse eosinophilic granuloma of the lung. On close inspection myriads of tiny cavities can be seen. Figure 13 is an example of an extremely rare condition, congenital adenomatoid malformation of a lung (7). At autopsy the left lung was overexpanded and honeycombed with small air-filled cysts.

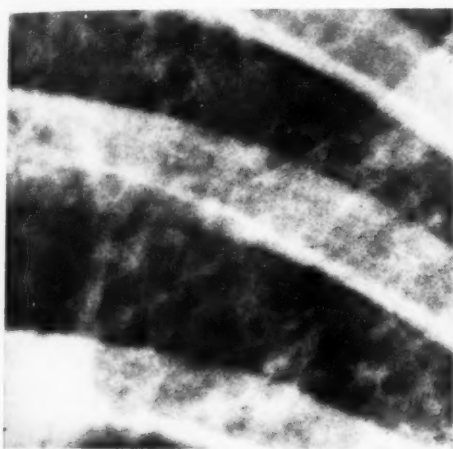


Fig. 12. Eosinophilic granuloma of the lung with diffuse honeycombing.

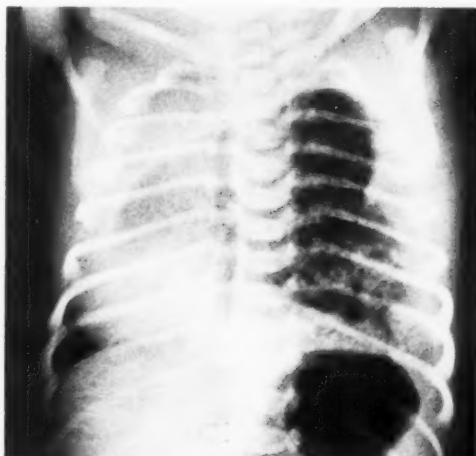


Fig. 13. Congenital adenomatoid malformation of the left lung with honeycomb pattern. The heart is displaced to the right and the overexpanded left lung has "herniated" across the midline. (Courtesy Dr. Frederic N. Silverman.)

cal with that from the mastoid. The patient died a number of years later and at autopsy the lung was full of tiny cysts. I believe the cysts were the result of partial bronchial obstruction by the small tumor-like granulomatous masses.

DR. FELSON: I would like to congratulate the panelists for their concise answers and excellent presentations. Theirs was truly an outstanding performance.

Benjamin Felson, M.D.  
Cincinnati General Hospital  
Cincinnati 29, Ohio

#### REFERENCES

1. RIGLER, L. G.: New Roentgen Sign of Malignancy in the Solitary Pulmonary Nodule. *J.A.M.A.* 157: 907, March 12, 1955.
2. SHANKS, S. C., AND KERLEY, P., editors: *A Textbook of X-ray Diagnosis by British Authors*. Philadelphia, W. B. Saunders, 2d ed., 1951, vol. II, p. 404.
3. GOUGH, J.: Correlation of Radiological and Pathological Changes in Some Diseases of the Lung. *Lancet* 1: 161-162, Jan. 22, 1955.
4. SIMON, M.: The Pulmonary Veins in Mitral Stenosis. *J. Fac. Radiologists* 9: 25-32, January 1958.
5. STEINER, R. E.: Radiological Appearances of the Pulmonary Vessels in Pulmonary Hypertension. *Brit. J. Radiol.* 31: 188-200, April 1958.
6. ARNOIS, D.-C., SILVERMAN, F. N., AND TURNER, M. E.: Radiographic Evaluation of Pulmonary Vasculature in Children with Congenital Cardiovascular Disease. *Radiology* 72: 689-698, May 1959.
7. CRAIG, J. M., KIRKPATRICK, J., AND NEUHAUSER, E. B. D.: Congenital Cystic Adenomatoid Malformation of the Lung in Infants. *Am. J. Roentgenol.* 76: 516-526, September 1956.

In addition to these conditions, we have seen this roentgen pattern in sarcoidosis, tuberous sclerosis, and scleroderma. Idiopathic examples are also encountered. Dr. McDonald, what is honeycomb lung?

DR. McDONALD: Honeycomb lung, as I have seen it, appears to be the roentgen counterpart of multiple dilatations of the small bronchi. I have seen a very unusual example of it in a patient with mastoid disease and lymph node enlargement in the neck. Biopsy of the mastoid showed tumor-like masses of granulomata associated with considerable fat. A cough subsequently developed and the chest roentgenogram showed a honeycomb pattern. The lung biopsy specimen appeared identi-

## SUMMARIO IN INTERLINGUA

## Alicun Principios in le Diagnose de Morbos Thoracic

In un discussion de gruppo plure expertos seligite a causa de lor profunde interesse e lor eminente contributiones in le campo del morbos thoracic presenta lor punctos de vista con respecto a certe problemas fundamental que es incontrate.

Le conditiones considerate per iste gruppo de specialistas es calcification in lesiones a forma de "pecias de moneta"; cavitation intra tal lesiones; lineas "B" de Kerley; le vasos intrapulmonar; liquido pleural; e pulmon faveolate.



In  
T  
in re  
posu  
posu  
upon  
shut  
tions  
in F  
i.e.,  
obje  
to be  
raph

Lens  
Old  
Ne  
n  
Shut  
Old  
(  
Ne  
n

(a)  
from  
S  
a g  
mill  
(c)  
use:  
pre  
is t  
gra  
I  
rad  
(c)  
(b)  
exi  
the  
ava

1  
Rad  
2  
ogr

# Kilovoltage and Radiographic Effect

Investigation Leading to a Standard X-ray Value Scale (X.V.S.) System of Simplified Exposures for Conventional and Automatic Radiography<sup>1</sup>

GERHART S. SCHWARZ, M.D.

THERE IS a fundamental analogy between photography and radiography in respect to determining the correct exposure factors. In photography the exposure on a given "material"<sup>2</sup> depends upon the following three factors: (a) the shutter speed expressed in seconds or fractions thereof; (b) the lens opening expressed in F/stops; (c) the brightness of the scene, i.e., the amount of light reflected by the object to be photographed. Factor (c) has to be measured or estimated by the photographer, whereas the setting of factors

more, nor cover all thicknesses which are encountered in medical practice.

In photography, a major recent advance in simplifying the calculation of the correct exposure factors is the international acceptance of the Exposure Value Scale system for the design of cameras. In the United States most new adjustable cameras now marketed are designed for this new "E.V.S." system, whereas in Germany and Japan the identical system has been adopted for all cameras under the designation "L.V.S." (Light Value Scale).

TABLE I: INTERNATIONAL E.V. INDEX NUMBERS AND OLD LABELS FOR CAMERA SETTINGS

Lens opening											
Old marking	F/1	F/1.4	F/2	F/2.5	F/4	F/5.6	F/8	F/11	F/16	F/22	F/32
New index number	0	1	2	3	4	5	6	7	8	9	10
Shutter setting											
Old marking (seconds)	1	1/2	1/4	1/8	1/16	1/30	1/60	1/125	1/250	1/500	1/1000
New index number	0	1	2	3	4	5	6	7	8	9	10

(a) and (b) are calculated or determined from tables or memory.

Similarly in radiography the factors for a given material are: (a) timer setting in milliamperes seconds; (b) the kilovoltage; (c) the thickness of the patient, which is a useful though somewhat inadequate expression of the amount of radiation which is transmitted by the subject to be radiographed.

Like his photographic colleague, the radiographer measures or estimates factor (c) and from it determines factors (a) and (b) by rote, formula, or table. None of the existing tables has been universal because they neither span the entire range of available kilovoltages from 40 to 125 kv or

This system consists of a set of simple index numbers assigned to the shutter settings and a similar set of numbers assigned to the lens-opening settings. A given sum of any two settings labeled by this new system will always effect the identical practical exposure regardless of the individual settings.

The internationally accepted figures are as given in Table I.

Under this new system the photographer needs to obtain only a single number from his light meter reading in order to use—without major calculation—a variety of combinations of timer settings and lens openings which will produce identical exposures. For example, if his meter shows

<sup>1</sup> From the Department of Radiology of the College of Physicians and Surgeons, Columbia University, and the Radiological Service of the Presbyterian Hospital, New York, N. Y. Accepted for publication in January, 1959.

<sup>2</sup> By "material" the photographer understands the combination of film type with processing, while the radiographer considers it the combination of the grid-screen-film sandwich with the processing.

an exposure value of 10, he can set his camera on  $5 + 5$  (F 5.6 and 1/30 sec.) or on  $8 + 2$  (F 16 and 1/4 sec.) or on  $2 + 8$  (F 2 and 1/250 sec.) and obtain a correctly exposed film each time. German manufacturers have gone one step further by mechanically cross-coupling timer settings and lens stops so that the sum of both index numbers remains preserved automatically over the entire range of the camera controls when the camera is set for a given exposure value.

This E.V.S. system is made possible by the fact that all available camera settings are deliberately chosen so that an increase of one step always increases the exposure by the same amount. This is nothing new in photography. For the past fifty years most cameras were designed so that one step up of each control increased the exposure by 100 per cent, *i.e.*, doubled it, whereas one step down cut the exposure in half. This is generally referred to as a full step. Some more expensive ancient cameras possessed aperture controls with smaller steps (so-called half-steps), which increased or decreased the exposure by  $\sqrt{2}$  per step. It required two steps up or down to double or halve the exposure for these cameras. In the past two decades it has become obvious that even direct transparency Kodachrome photography, which possesses the narrowest range of permissible exposures, does not require any less than a full step for available camera controls. Recognizing this fact, several manufacturers have lately equipped their most expensive camera models with automatic diaphragms or click stops which make impossible or discourage the use of any smaller variation of settings than a full step.

Unfortunately, x-ray manufacturers have completely disregarded this principle (with one exception) and have neither provided equidistant steps for their control stands nor limited the size of the smallest available variation to a full step or a half step, etc., despite the fact that the radiographic process possesses a latitude almost twice that of Kodachrome pho-

tography (2). This was not entirely due to ignorance or negligence. In photography it was simple to arrive at the present design of cameras because the function of factor (*a*) as well as factor (*b*) was well known and mathematically defined. The photographic effect is a linear function of the shutter speed (if one disregards slight reciprocity failure) and varies with the inverse square of the F-stop (if one disregards glass absorption, internal reflection, and scattering). It was therefore easy to design camera controls with equidistant steps. Not so in radiography. In radiography only factor (*a*) is well defined, and its function obvious in that the radiographic effect is clearly a linear function of the mas setting (disregarding reciprocity failure); indeed, it would be easy to provide timer settings with steps which would double the preceding setting with each step. The stumbling block to an effective E.V.S. system in radiography is the inconstant relation of the kilovoltage to the radiographic effect.

The purpose of the investigation to be described here was to determine the influence of kilovoltage upon the radiographic effect over the widest available range of machine settings, under simulated and actual clinical radiographic conditions and to establish a universal exposure system which approaches the E.V.S. system of photography.

Morgan (6-8) and Mattsson (5) have carefully examined the individual factors affecting the required exposure for an optimal radiograph as a function of kilovoltage. In the present investigation only the end-effect, *i.e.*, the summation of factors, is of interest. In approximation, it may be stated that the radiographic effect increases with the kilovoltage for the following reasons:

1. The roentgen output of the x-ray tube rises with the kilovoltage when the milliamperage is kept constant because (*a*) the kilowatt power applied to the tube increases and (*b*) the efficiency of energy conversion within the target improves. The higher the filtration, the faster the rise.



2. The speed, *i.e.*, the radiosensitivity of the screen-film sandwich, increases with the kilovoltage. This is primarily a function of the screens.

3. The transmission of x-rays through the patient rises with the kilovoltage. The thicker the radiographed part, the faster the rise.

Combining all three factors, it has been postulated that the total radiographic effect rises with the fifth power of the kilovoltage. Bierman and Boldingh published their findings in support of this assumption in 1953 (1). Gilardoni *et al.* have accepted the Bierman-Boldingh exponent as a means of calibrating the tube voltage of x-ray machines (4). X-ray technicians have for decades used the rule that an increase of 10 kv permits one to cut the mas exposure in half. This is incorrect when applied to a wide range of voltages and thicknesses but is of some value when applied to 10-kv increments in the 60- to 80-kv range. Incidentally, the 10-kv step from 67 to 77 kv (an increase of 14.9 per cent) coincides with the fifth power rule.

One European manufacturer has recently marketed a radiographic machine based upon this concept that the fifth power is a universal exponent. He claims that the available kv steps are equivalent to the ma increments provided in its controls, so that a step-up of voltage can be counteracted by a step-down on the ma control. Such a machine would lend itself ideally to the E.V.S. system and could also be automatized. Measurements indicate, however, that the exponent is not universal but varies with the thickness of the part examined as well as with the kilovoltage, so that automation is not simple within the complete range of factors needed for universal clinical application. Also, the manufacturer was unaware of the fact that small steps are undesirable in radiography and provided 25 per cent ma increases and 5 per cent kilovoltage increments.

#### METHOD OF INVESTIGATION

Test exposures were made through a

Masonite-bone phantom which provided the following major steps:

(a) 2.5 and 4 cm. Masonite under finger and anteroposterior wrist bones.

(b) 5 cm. Masonite under lateral wrist and elbow bones.

(c) 10, 20, and 28 cm. Masonite under an anteroposterior pelvis and anteroposterior lumbosacral spine.

(d) 30 and 40 cm. Masonite under a lateral lumbosacral spine and pelvis.

Aged dry bones superimposed upon Masonite were used, containing mainly air in addition to their mineral components. This represented a fair equivalent to a water phantom with submerged "wet" bones.

As criteria for a *correct* exposure, optimum bone visualization was selected because experience has shown that rarely will a radiograph be rejected by the radiologist when bones are well depicted, even when diagnostic interest is centered upon a nonskeletal structure, such as a kidney on a pyelographic film.

Test exposures were thus made with varying kilovoltages to determine the exact doubling and halving points for each of the aforementioned thicknesses. A doubling point was considered to be that kilovoltage at which the milliampereseconds had to be doubled to produce the same radiographic bone density; a halving point, that kilovoltage at which the reverse was true. A master radiograph was taken at 60 kvp, and doubling and halving points were determined between 28 and 133 kvp for each of the phantom steps. These points were then charted on graph paper and connected by curves (Fig. 1). This graph made it apparent that no universal exponent existed. Where the doubling and halving curves approach each other most closely, the exponent is highest, and *vice versa*. Thus the exponent decreases with a rise in kilovoltage but increases with the thickness of the radiographed part.

Under actual clinical working conditions, these two trends compensate each other to a considerable degree because the lowest kilovoltages are employed mainly in the

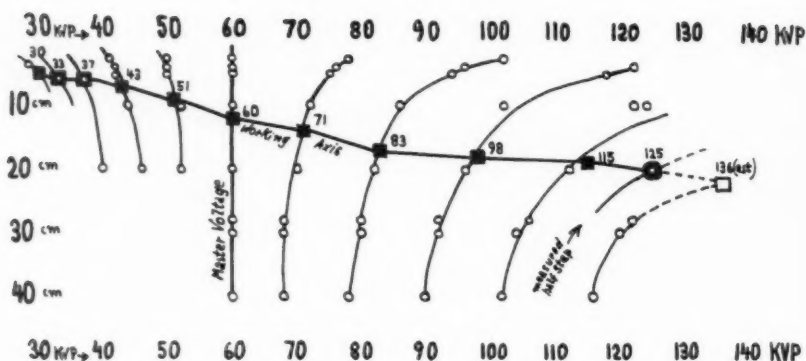


Fig. 1. Doubling and halving curves with 60 kVp as master voltage (for all thicknesses from 2 to 40 cm. Rings indicate actually measured kilovoltage doubling and halving points (O).

Key to symbols: ■ standard doubling point chosen for working axis. □ standard doubling point which happens to coincide with measured doubling point. ○ estimated standard doubling point. ● measured and chosen half-step doubling point.

radiography of thin parts, whereas the highest kilovoltages are used when large parts are to be penetrated.

An example of the marked variability of the exponent is given in Fig. 2. It shows the size of the exponent at 60 kVp

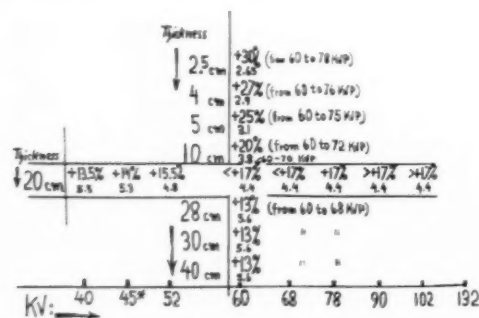


Fig. 2. Doubling kv intervals for all thicknesses at 60 kVp and for all kv steps at 20 cm. expressed in per cent. Small figure below percentage figure indicates the theoretical exponent of the kilovoltage function which fits this interval. The exponent rises with the thickness of the radiographed part but drops with an elevation of the kVp.

for all thicknesses and for 20 cm. at all kVp's. It indicates that the exponent varies from 2.65 to 5.6 even in the limited range depicted here. In order to obtain a better orientation of the variation of the exponent, "overall" exponents have been fitted to groups of doubling intervals, as shown in Fig. 3.

In arriving at a unit system similar to

Thickness	30-60 KV	60-120 KV
2.5 cm	3.6	2.6
5 cm	4.	3.2
10 cm	4.8	4.
15 cm	5	4.2
20 cm	5.2	4.4
		30 cm 5.
		40 cm 5.3

Fig. 3. Overall exponents grouped into two kilovolt ranges.

the EVS system of photography, it was decided to abandon the concept of a universal exponent and select standard doubling points based upon experimentation. The doubling points so chosen were those which lay near actual working conditions, i.e., for lower kilovoltages, the doubling points were applied to radiography of thin parts, for higher kVp's to the filming of thick parts.

The doubling points so selected were then entered on the graph of Figure 1 and connected by straight lines. The resulting line, which constitutes the "working axis," connects all thicknesses and kilovoltages for which the unit system yields the absolutely correct exposure (Fig. 1). This working axis is seen to slope gently downward from 5 cm. at 30 kVp to about 18 cm. at 83 kVp. At this point the

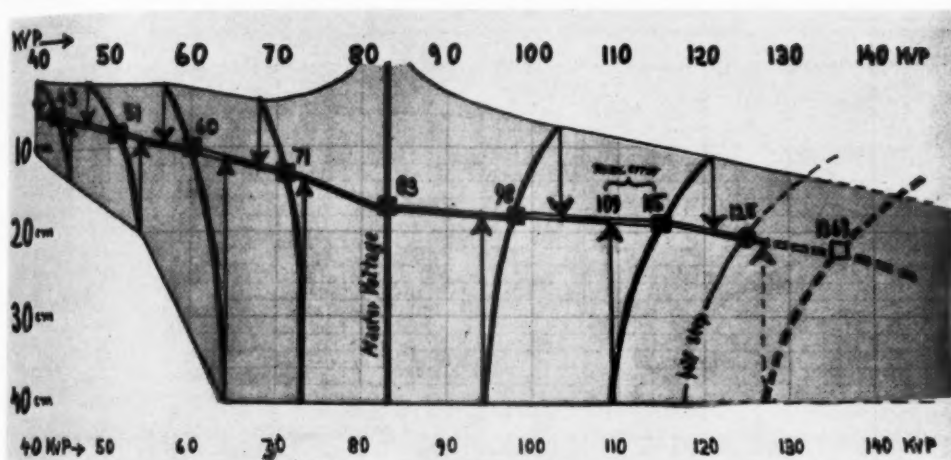


Fig. 4. Doubling and halving curves for a master voltage of 83 kvp.\* Shaded area represents the working zone in which the maximum error does not exceed one-third of a step.

The maximum error occurs when machine settings at the margin of the working zone are used. Extent of error is shown by dropping plumb lines onto working axis (arrows). Distance of standard doubling point from point of intersection indicates error.

*Example shown:* Correct exposure for given mas and an anatomic part measuring 40 cm. is 109 kvp. Using the standard unit system, the exposure would be 115 kvp instead (approx. one-third of a full step). The system tends to slight overexposure of heavy patients and to slight underexposure of thin patients when marginal machine settings are used. This is a favorable feature.

\* In actual operation, the master voltage is that value for which the standard unit caliper scale is made to read exactly. In this paper all standard unit calipers described are made for a master voltage of 83 kvp.

working axis turns horizontal because an acceptable distance from the maximum centimeter thickness of 42 cm. which occurs in radiography has been reached, so that no further thickness increments are needed. The working axis remains horizontal until it dips again after 115 kvp, this time in order to keep the maximum error constant, as will be shown in the following.

#### MAXIMUM ERROR

The working axis on which all standard doubling kilovoltage steps lie, is surrounded by a broad zone of acceptable working exposures which traverses the table obliquely. Its width varies and depends upon two major factors: the maximum error one is willing to accept and the proximity to the master kilovoltage. At the master kilovoltage the error is zero for all thicknesses and the width of the acceptable zone is therefore infinite.

Figure 1 is based on a master kilovoltage of 60 because it so happened that this voltage had been selected as the starting

point of all measurements. It was found to be an impractical value to serve as the starting point of a universal unit system, however, because it is too far removed from the higher kilovoltages now in use. For the standard unit system a master kilovoltage of 83 was therefore chosen. This erects the 83-kvp doubling curve and transforms it into a straight vertical line, whereas the 60-kvp line now becomes a curve (see Fig. 4). Now, the error of the unit system is zero at 83 kvp for all thicknesses. At other kilovoltages, it is zero only for that thickness which happens to lie on the working axis. Figure 4 shows the width of the working zone when one is willing to regard one-third of a step as an acceptable error. The zone is adequately broad and covers more machine settings than occur under actual working conditions. As has been discussed before, even an error larger than one full step may be tolerated. A one-third step error is thus an extremely conservative requirement.

An acceptable one-third step error constitutes a permissible kilovoltage devia-

TABLE II: PROPOSED STANDARD FOR MACHINE LABELING ACCORDING TO THE BASIC SYSTEM

Index	-3	-2	-1.5	-1	-0.5	0	+0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	(7)
Kilovoltage (kvp)	30	33	35	37	40	43	47	51	55	60	65	71	77	83	90	98	105	115	125	(140)
		-3.5		-3		-2		-1		-0.5		0		1		2		2.5		etc.
Index		1		1.5		3		6		9		12.5		25		50		75		
Milliamperage (ma)		3		3.5		4		4.5		5		6		6.5		7		7.5		etc.
		100		150		200		300		400		800		1100		1600		2200		etc.
												(10)		(1000)				(2000)		
Index		0		1		2		3		4		5		5.5		6		6.5		7
Timer settings (seconds)		$\frac{1}{1000}$		$\frac{1}{100}$		$\frac{1}{200}$		$\frac{1}{150}$		$\frac{1}{60}$		$\frac{1}{30}$		$\frac{1}{20}$		$\frac{1}{15}$		$\frac{1}{10}$		$\frac{2}{15} = \frac{1}{7.5}$
				7.5		8		8.5		9		9.5		10		10.5		11		11.5
				$\frac{1}{8}$		$\frac{1}{4}$		$\frac{2}{5}$		$\frac{1}{2}$		$\frac{4}{5}$		1		$1\frac{1}{2}$		2		3
				OR $\frac{1}{6}$				OR $\frac{7}{20}$				OR $\frac{7}{10}$								

TABLE III: PROPOSED STANDARD FOR BASIC X.V.S. CALIPER SCALE

For Bucky technic (ratio 8:1 up to and including 83 kvp; 16:1 above 83 kvp)																				
cm.	4	5	6	7	8	9	10	11.5	13	14.5	16	18	20	22	24	26	28	31	34	37
X.V. units	10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5	16	16.5	17	17.5	18	18.5	19	19.5
For no-grid table-top technic																				
cm.	0.3	0.5	1.0	2	3.5	5	6.5	8	9.5	11	12.5	14								
E.V. units	5	6	7	8	8.5	9	9.5	10	10.5	11	11.5	12								
For 6-foot or 2 meter no-grid chest technic																				
cm.	16	18	20	22	24	26	28	30	32	34	36	38	40							
X.V. units	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5	16	16.5	17							

tion of from  $\pm 5$  to  $\pm 10$  per cent. It will be noticed that the working axis happens to possess a constant exponent of its own, namely 4.3 for the kilovoltage doubling steps over the range from 43 to 115 kv. This is immaterial; no common exponent is needed for the unit system, nor does the exponent remain 4.3 below 43 or above 115 kvp.

#### DEVELOPMENT OF A UNIT SYSTEM

One method of arriving at a unit system suited to departmental, national, and international standardization consists of labeling all machine controls with index figures, each whole number representing a full step. A half number represents, then, a half step ( $= \sqrt{2}$  or 40 per cent).

The ordinary caliper, used by x-ray technicians for measuring the patient's thickness, is relabeled to read in x-ray value (X.V.) units instead of centimeters in analogy to the modern photographic light meter, which reads in E.V. units; previously its scale was graduated in foot candles.

One can then standardize either the machine labels or the caliper scale. One

of the two must be variable to make it possible to adjust the system to filtration, film or screen speed, and local processing conditions. In photography, the dial of the exposure meter is the variable that adjusts to film speed and filtration (correction for processing is done mentally by the photographer). In radiography either method has its special advantages. Both have been used in this department.

A basic and a practical standard unit system were developed and proposed for ASA and international standardization. The index numbers shown in Table II are proposed to suit the basic system.

For Blue Brand film, par speed screens, 3.5 mm. aluminum filtration, a T.F.D. of 40 inches, and 5 minutes (full) development or X-Omat processing, the caliper scales shown in Table III were found to give best results.

For other grids, filters, screen film types, and distances, different caliper scales or machine labels can be provided.

#### OPERATION OF THE UNIT SYSTEM

The x-ray technician measures the anatomical part to be radiographed with the unit caliper. He sets his three machine

TABLE IV: ACTUAL LABELING OF A MACHINE OPERATING ACCORDING TO THE PRACTICAL UNIT SYSTEM

Index	0	1	2	3	4														
kv	60	71	83	98	115														
Index	0	1	2	3															
ma	50	100	200	400															
Index	0	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8			
Seconds	$\frac{1}{40}$	$\frac{1}{30}$	$\frac{1}{20}$	$\frac{1}{15}$	$\frac{1}{10}$	$\frac{2}{15}$	$\frac{1}{5}$	$\frac{1}{4}$	$\frac{7}{20}$	$\frac{1}{2}$	$\frac{7}{10}$	1	$1\frac{1}{2}$	2	3	4			

TABLE V: ACTUAL LABELING OF A MACHINE OPERATING ACCORDING TO THE PRACTICAL UNIT SYSTEM BUT LIMITED TO LOW KV'S AND MADE COMPATIBLE WITH MACHINE LABELED AS IN TABLE IV

Index	0	1	2	3	4														
kv	43	51	60	71	83														
Index	0	1	2																
ma	50	100	200																
Index	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7					
Seconds	$\frac{1}{10}$	$\frac{2}{15}$	$\frac{1}{5}$	$\frac{1}{4}$	$\frac{2}{5}$	$\frac{1}{2}$	$\frac{4}{5}$	1	$1\frac{1}{2}$	2	3	4	6	8					

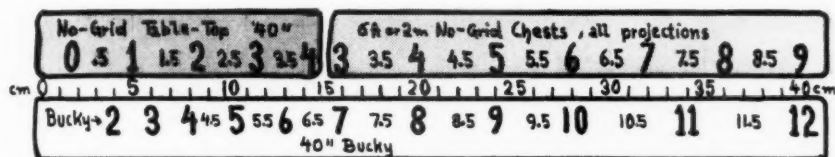


Fig. 5. Standard unit caliper scale for the practical system. This scale can be applied to high- as well as low-kilovolt technics and is basic in that the smallest exposure likely to occur in medical radiography is labeled zero. The highest E.V. figure (12) represents then an exposure more than 4,000 times the former.

This scale does not include graduations for nonscreen technic, in which the patient exposure is considerably higher. For Blue-Brand film in cardboard holders 4 E.V. units have to be added to the measurement obtained. When nonscreen film is used in these holders, the figure to be added is only 2.5.

The centimeter scale in the center is absent from the actual caliper. It is shown here only to demonstrate the position of the labels on the caliper. On the calipers used in this department the scales are color coded: white for Bucky technic, red for no-grid table-top cassette (with screens) technic, and yellow for no-grid chest teleradiography (see also Fig. 6).

controls (kv, ma, and timer) on such index figures that their sum equals the exposure value read off the unit caliper scale. This will effect an acceptable exposure regardless of the individual settings selected. Equivalent high-kv and low-kv radiographs of the same part can be obtained instantly. Likewise, equivalent fast-timed high-ma and slow-timed low-ma technics can be set interchangeably without delay. No exposure table need be consulted.

*Intentional Restriction of the Technician's Choice (Limited Standard Unit System):* The unit system as described so far will be referred to as basic in the following because it permits an unlimited choice of factors and provides for future technological developments such as faster films and screens without necessitating negative index

figures. In actual operation at the Presbyterian Hospital, however, it displayed two disadvantages:

- (1) The X.V. figures are too high for convenience in mental calculation.
- (2) Too many choices in setting the controls are possible.

A practical unit system was therefore developed which overcomes these difficulties and could be limited if so desired. A standard caliper was made which possessed the same basic scale of 13 steps as the one used for the basic system, except that they were labeled from 0 to 12, so that each X.V. value was eight points less than on the basic model. Its scale is shown on Figs. 5 and 6.

The machine labels were arbitrarily chosen so as to: (a) suit the particular technic which was favored in a given



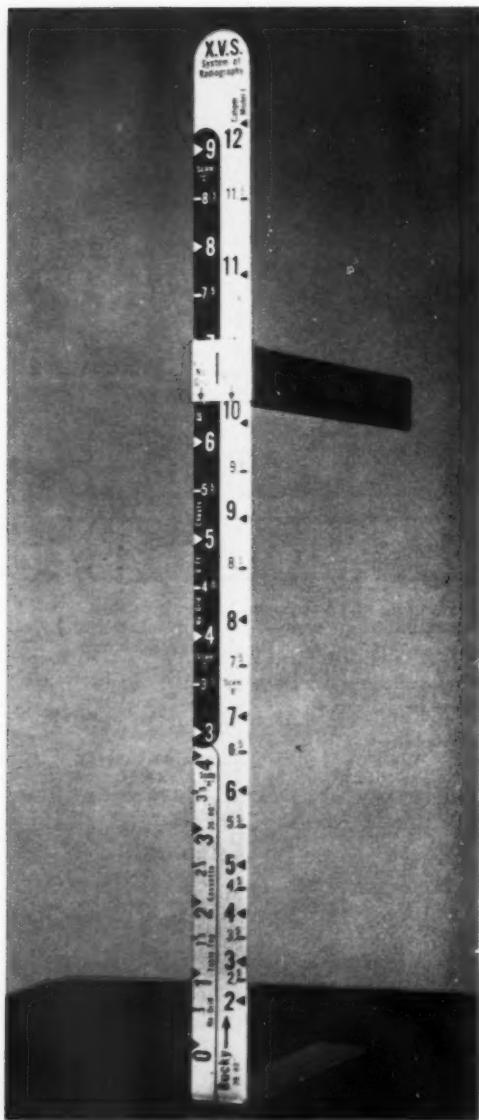


Fig. 6. X.V.S. caliper now in use.

section of the department; (b) fit the capacity of a given machine; (c) be compatible with each other throughout the department.

Some examples of machine labelings may be cited:

In a section of the department in which high-kv technic was favored, machine *A* was labeled as shown in Table IV.

In another section low kilovoltage was favored because of an ancient generator and timer. The labels shown in Table V were applied to machine *B*.

It can easily be seen that both machines are completely interchangeable when the identical standard caliper is being used for both because all labels are made "compatible." For example, the technician attempting to take a lateral view of the lumbosacral spine of a large patient who measures 12 X.V. units may set machine *B* on  $4 + 2 + 6 (=12)$ . This produces the following settings: 83 kvp, 200 ma, and 4 seconds. Should he decide to take his patient to machine *A* he could set it on  $2 + 2 + 8 (=12)$ . This leads him to the identical settings, namely 83 kvp, 200 ma, and 4 seconds. Machine *A*, however, makes it possible to use high-kv technic as an alternative. He may set his machine on  $4 + 2 + 6 (=12)$  instead. This corresponds to the following settings: 115 kvp, 200 ma, and 1 second and also produces a correct exposure.

It is possible, therefore, to mix an unlimited number of machine types and technics in an x-ray department and yet require only a single scale for all standard calipers made available to the technicians. By removing labels from the control panel, the choice can be further restricted. Care must be taken, however, not to restrict labels to a point where a necessary exposure can no longer be effected.

Some machines possess Liebel-Flarsheim timers which are graduated in decimal steps. The principle is to follow the F/stop labels of photographic cameras and allow a 10 to 20 per cent mas deviation; e.g., for machine *A* one would employ the labels shown in Table VI.

The limited and unlimited practical unit system has been in operation in selected sections of the department for several months. Since these sections feed their films into an X-Omat, an erroneous exposure cannot be corrected by processing. The number of rejects is definitely less than with the conventional system, apparently because gross human errors occur less fre-

TABLE VI: DECIMAL TIMER LABELING; EXAMPLE FOR MACHINE A (OF TABLE IV)

Index	1.5	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8
Seconds	$\frac{1}{20}$	0.1	$\frac{3}{20}$	0.2	0.3	0.4	0.6	0.8	1.0	1.4	2.0	2.8	4.0

quently. Those radiographs which were taken by the author have been invariably optimal or near optimal except in chest radiography. Those taken by technicians were subject to moderately frequent errors. These errors were not serious enough, however, to require a repeat exposure, so that often a day's load of 100 films required only one or two repeats because of incorrect exposure. Technicians using the system felt that it facilitated their work.

Films taken with the unit system were occasionally compared with those taken with phototiming. The former were usually superior. The proper adjustment of the phototimer could not be ascertained, however.

Slight difficulties have been experienced with the chest scale in that some observers preferred light radiographs, whereas others favored dark films. Two editions of this scale were made, therefore, to satisfy individual preferences. They differ from each other by a full step. The one shown here (Fig. 5) is the one which produces light exposures. Actually, individual tastes of observers were as far apart as one and one-half steps, *i.e.*, three times the mas.<sup>3</sup> This testifies to the enormous latitude of the radiographic process and the futility of providing small steps on machine controls. The unit system here described could easily be operated with full steps alone. With half steps the largest deviation from the "ideal" exposure cannot exceed 1/4 step, which equals 19 per cent mas ( $\sqrt{2}$ ) or a 3-5 per cent kvp variation. Half steps have been provided in part as a concession to some users and in part as a means of compensating more accurately for technological

progress. Most screen and film manufacturers market new products whenever they succeed in raising their speed by one half step ( $= 40$  per cent or  $\sqrt{2}$ ) because they realize that a smaller gain would not be a significant advantage. It is easy then to compensate for each new product by changing the scale by a half step whenever such a technological advance occurs.

As part of the A.S.A. and international standard proposal the recommendation is made here, therefore, that manufacturers agree to continue this admirable policy. This recommendation is a timely one, for the recent radiation scare has provided anyone who can claim to reduce the radiation to the patient by even the most insignificant amount with a considerable sales advantage. The temptation to rush into the market with products that are only 10 per cent faster than their predecessors is mounting and would lead eventually to confusion.

#### APPLICATION OF THE UNIT SYSTEM TO FUTURE MACHINE DESIGN

The purpose of the unit system goes beyond speed and convenience of operation of existing machines. It makes it possible for the manufacturer either to produce simpler machines at reduced cost or to design an automatic machine with little additional cost as compared with present-day equipment.

(A) The simplified model possesses only 4 or 5 kv, 2 or 3 ma, and about 15 timer settings. Supplied with an X.V. standard caliper, such a control can cope with any medical radiographic exposure problem and might be suited to army field units. Push button selectors might further simplify its operation.

The extreme form of simplification may be termed "pseudo-automatic." One can eliminate kv and ma controls entirely and provide a single unalterable setting of these factors instead. The only variation then

<sup>3</sup> The chest scale was found empirically to possess equidistant graduations. This makes it possible to slide it up and down the caliper for changing to the preferred density of a routine chest technic without affecting the already adjusted general Bucky scale. Thus the chest scale can be balanced against the bone scale according to personal taste.

TABLE VII: EXAMPLE OF A PSEUDO-AUTOMATIC CONTROL LABELING OF A MACHINE IN OPERATION, USED FOR GASTROINTESTINAL WORK

Index	0										
kv	115										
Index	0										
ma	200										
X.V. value	7.5	8	8.5	9	9.5	10	10.5	11	11.5	12	
Seconds	$\frac{1}{20}$	$\frac{1}{15}$	$\frac{1}{10}$	$\frac{2}{15}$	$\frac{1}{5}$	$\frac{1}{4}$	$\frac{2}{5}$	$\frac{1}{2}$	$\frac{4}{5}$	1	

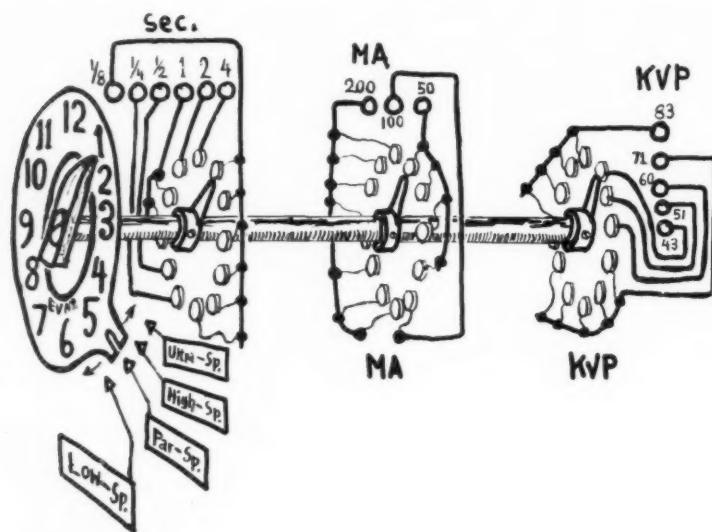


Fig. 7. Basic theoretical design of a single-knob control unit. For legibility half steps have been omitted here. Example is for a simple timer with shortest exposure time of 1/8 second. Only one combination of settings is made available for each X.V. value as follows:

Example for inexpensive generator (200 ma and 85 kvp maximum) and timer (1/8 second shortest), attached to a 13-channel television switch

X.V. No.	0	1	2	3	4	5	6
kv	37	43	51	60	71	71	71
ma	50	50	50	50	50	100	200
Sec.	1/8	1/8	1/8	1/8	1/8	1/8	1/8
(mas)	(6)	(6)	(6)	(6)	(6)	(12)	(24)

X.V. No.	7	8	9	10	11	12
kv	71	71	71	83	83	83
ma	200	200	200	200	200	200
Sec.	1/4	1/2	1	1	2	4
(mas)	(50)	(100)	(200)	(200)	(400)	(800)

This is accomplished by attaching all 3 controls to a common Bakelite axle. Each step produces twice the radiographic effect of its predecessor.

Setting 12 represents an exposure more than 4,000 times greater than setting 0.

available is that of the timer, and timer labels are identical with the X.V. reading of the caliper. Such a design is in operation in one of the gastrointestinal sections of our department. This was accomplished by affixing the compatible labels shown in Table VII to a conventional machine. The resulting performance was satisfactory and automatic in the sense

that there was only one set of figures onto which the machine had to be set. They coincided with the figures on the caliper scale. The mental calculation of adding index figures was thus eliminated. Operation, however, was confined to gastrointestinal work. To make such a unit applicable to all medical radiographic conditions, a timer is needed that provides

short exposures down to 1 millisecond. This requirement can be modified by providing an automatic switch which drops the kilovoltage one or two unit steps at the lower end of the timer scale and raises it one and two unit steps at the top of the timer scale. This extends the range of

kv and ma button which he desires to use, whereupon the correct third control springs automatically into place. An incorrect exposure is thus nearly impossible. If the operator so desires, he can select the ma and timer settings he prefers. The correct kilovoltage will then set itself automati-

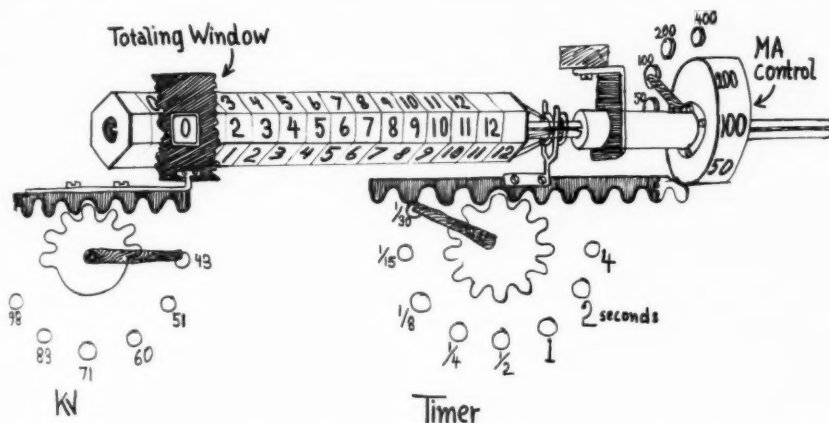


Fig. 8. Prototype of a semiautomatic control stand. All three controls act upon a mechanical adding machine so that the sum of all three index numbers appears in the totaling window. Whenever the controls are set so that the X.V. figure in the totaling window is identical with the caliper measurement, a correct exposure is obtained. (In the fully automatic version the operator sets a single totaling dial upon the X.V. figure read off the caliper, whereupon an electronic brain activates the controls so that they add up correctly to conform to the desired contrast.)

the machine while it permits the use of a conventional timer. This now semiautomatic machine possesses a single knob control (Fig. 7). The choice of available settings is made to stay within the tube limit. Safety devices can therefore be dispensed with. It provides the shortest timing, highest kilovoltage, and lowest radiation dose possible for any of its 24 stations automatically when so desired.

#### AUTOMATION

The purpose of automation is to free the x-ray technician from the need of adding three figures and thereby to prevent exposure errors. The unit system makes automation simple. The control stand of an automatized machine would contain a mechanical or electronic adding machine. The technician turns the totaling dial of the control panel on the X.V. figure which he has read off the caliper after measuring the patient. He pushes the

cally. This is accomplished by a simple mechanical or electronic adding machine which cross-couples all three controls, such as a notched bar mounted behind the control panel which blocks all but the right push button (Fig. 8).

For *super-automatic control*, a sprung unit caliper is attached permanently to the x-ray table and chest stand. Its radiolucent cross-member rests on the patient during exposure and telegraphs the X.V. value to the control stand, which sets itself accordingly.

#### SUMMARY

Several hundred test exposures of a Masonite bone phantom were made and the exact doubling and halving kilovoltages from 28 kvp to 133 kvp were determined for all thicknesses from 2 to 42 cm. It was shown that no single exponent for the radiographic effect as a function of kilovoltage existed. The exponent varied

with the thickness of the radiographed part and the kilovoltage range used.

By charting all correct exposures, however, and selecting those kilovoltage doubling and halving points as standard points which lay on a "working axis," it was possible to develop an X.V.S. unit system of radiographic exposures similar to the E.V.S. system of photography, which has become an international standard.

The working axis extends obliquely across the table from the thinnest part at the lowest kilovoltage to the thickest part at the highest kilovoltage and is surrounded by a working zone of radiographic settings. This zone covers all settings used in medical radiography. The maximum deviation from the optimal exposure is one-third step and is negligible.

The controls of x-ray machines are labeled with index figures which represent standardized unit steps. A twelve-step unit caliper graduated in standardized exposure value numbers is used to measure the patient. The x-ray technician sets the three machine controls (kv, ma, and timer) on those index figures the sum of which totals the X.V. value read off the caliper scale. This effects a correct exposure regardless of whether he selected a high or low kilovoltage or short or long timer setting and eliminates the necessity of consulting an exposure table.

Proposed A.S.A. standards for machine labeling and caliper scales are given. The unit system as described applies to existing radiographic machines. It affects, however, also the design of future machines in that it eliminates unnecessary control steps, permits standardization of machine parts, films, and screens, and makes possible partial and complete automation leading to a single knob control.

#### ADDENDUM

The technical exhibits at the Ninth International Congress of Radiology made it clear that most European control stands now in manufacture possess only two final variable settings, namely kilovoltage and milliamperes seconds. They feature a direct reading milliamperes second meter which is being set

by the operator before the exposure is made. This further simplifies the X.V.S. system. Only two index figures instead of the previously described three then have to be added. The X.V.S. caliper remains unchanged.

*Example:* The control panel of a machine labeled according to Table IV can be reduced therefore to the following simpler system:

Index	0	1	2	3	4	(5)					
kvp	60	71	83	98	115	(140)					
Index	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	
mas	0.7	1	1.4	2	3	4	6	8	12	18	
	5	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10
	25	35	50	70	100	150	200	300	400	600	800

622 W. 168th St.  
New York 32, N. Y.

#### REFERENCES

1. BIEMAN, A., AND BOLDINGH, W. H.: The Relation Between Tension and Exposure Time in Radiography. *Acta radiol* **35**: 22-26, January 1951.
2. Experiments by the author.
3. FRANTZELL, A.: The Practical Radiographic Importance of Reciprocity Law Failure. *Acta radiol* **34**: 6-16, July 1950.
4. GILARDONI, A., GHISLANZONI, T., VANONI, F. P., AND TACCANI, A.: A Fundamental Method of Determining the Radiographic Efficiency of X-Ray Machines. *X-Ray Technician* **29**: 159-161, November 1957.
5. MATSSON, O.: Practical Photographic Problems in Radiography with Special Reference to High-Voltage Technique. *Acta radiol*, Suppl. 120, 1955.
6. MORGAN, R. H.: An Analysis of the Physical Factors Controlling the Diagnostic Quality of Roentgen Images. Part I. Introduction. *Am. J. Roentgenol* **54**: 128-135, August 1945. Part II. Maximum Resolving Power and Resolution Coefficient. *Am. J. Roentgenol* **54**: 395-402, October 1945. Part III. Contrast and the Intensity Distribution Function of a Roentgen Image. *Am. J. Roentgenol* **55**: 67-89, January 1946. Part IV. Contrast and the Film Contrast Factor. *Am. J. Roentgenol* **55**: 627-633, May 1946.
7. MORGAN, R. H.: Characteristics of X-Ray Films and Screens. *Radiology* **49**: 90-94, July 1947.
8. MORGAN, R. H., AND VAN ALLEN, W. W.: The Sensitometry of Roentgenographic Films and Screens. *Radiology* **52**: 832-845, June 1949.
9. MORGAN, R. H.: Reciprocity Law Failure in X-Ray Films. *Radiology* **42**: 471-479, May 1944.
10. SCHWARZ, G. S.: A Simple Universal Unit System of Radiographic Exposures Suited to Departmental, National, and International Standardization (Work In Progress). *Radiology* **71**: 573-574, October 1958.
11. SEEMANN, H. E., AND SPLETTSTOSSER, H. R.: The Effect of Kilovoltage and Grid Ratio on Subject Contrast in Radiography. *Radiology* **64**: 572-580, April 1955.
12. SEEMANN, H. E., AND SPLETTSTOSSER, H. R.: Kilovoltage and Grid Relationships in Radiography of a Pelvic Phantom. Exhibit at the 43rd Annual Meeting of the Radiological Society of North America, Palmer House, Chicago, Nov. 17-22, 1957.
13. SPIEGLER, G.: *Physikalische Grundlagen der Röntgendiagnostik*. Stuttgart, Georg Thieme, 1957.
14. TROUT, E. D., GRAVES, D. E., AND SLAUSON, D. B.: High-Kilovoltage Radiography. *Radiology* **52**: 669-683, May 1949.



## SUMMARIO IN INTERLINGUA

**Kilovoltage e Effecto Radiographic: Investigationes Resultante in le Establimento de un Scala de Valores de Radios X (S.V.X.) al Uso Como Systema Standard de Expositiones Simplificate in Radiographia Conventional e Automatic**

Esseva effectuate plure centenas de expositiones experimental de un osso phantoma de Masonite, e le exacte kilovoltages duplicante e bisecante ab 28 kvp usque a 126 kvp esseva determinate pro omne spissitates inter 2 cm e 42 cm. Esseva demonstrate que il non existe un unic exponente pro le effecto radiographic como function del kilovoltage. Le exponente variava con le spissitate del pecia radiographate e le gamma de kilovoltages usate.

Tamen, per notar graphicamente omne le correcte expositiones e per seliger como punctos standard ille punctos de duplicamento e de bisecamento de kilovoltage le quales esseva locate super un "axe de labor," il esseva possibile disvelloppar un scala de valores de radios X (S.V.X.) representante un systema de unitates pro le exposition radiographic que es simile al correspondente systema nunc in uso como standard international in le photographia.

Le axe de labor curre obliquemente a transverso le tabula ab le plus tenue pecia al plus basse kilovoltage usque al plus spisse pecia al plus alte kilovoltage e es circumdate de un zona de labor de collocaiones de radiographia. Iste zone include omne le collocaiones usate in radiographia medical. Le deviation maximal ab le exposition optimal es un tertio de un

passo de graduation, e isto es negligibile.

Le dispositivos de controlo del machina de radios X es etiquettate con cifras-indice que representa standardisate passos o unitates. Un calibrator a dece-duo passos-unitates, graduate in standardisate cifras de valor de exposition, es usate pro mesurar le patiente. Le technico ajusta le tres dispositivos de controlo in le machina (i.e. le selectores de kilovolt, milliampere, e duration) de maniera que le summa total del cifras-indice seligite es equal al valor trovate per le mesuration del patiente con le calibrator. Isto resulta in un exposition correcte, sin reguardo a si un alte o basse kilovoltage o a si un longe o breve duration es usate, e elimina le necessitate de consultar un tabula de expositiones.

Es presentate standards proponite al Association American de Standards pro le etiquettage de machinas. Es etiam presentate scalas de calibrator. Le systema de unitates hic describe es applicabile al existente machinas radiographic. Tamen, illo etiam affice le construction de machinas futur in tanto que illo elimina mesuras\* superflue de adjustamento, permette le standardisation de partes del machinas, de pelliculas, e de ecrans e rende possibile le automatisasion partial e mesmo complete, con le resultado final del introduction de un sol button de controlo.



## A Localization Scheme for Radiation Therapy Planning with the Theratron

H. B. LATOURETTE, M.D.,<sup>1</sup> C. S. SIMONS, Ph.D., and I. LAMPE, M.D.

**A**MONG the factors leading to effective treatment of malignant lesions are the precise localization of the involved tissue and its accurate exposure to adequate doses of radiation over a period of time. The use of protracted therapy makes imperative some means of insuring that the treated volume, kept as small as clinically feasible, is being irradiated consistently from day to day. The use of rotational technics accentuates the need for accurate localization methods that can be applied to different sites, with allowance for individual anatomic variations.

With the Theratron the requirement of consistency of irradiation is most easily achieved by adopting a standard position for all treatments. In our practice, the patient is in the supine position, squarely on his back, on a full-length, 1-inch thick foam-rubber pad, spread on the treatment couch. With hands either across his chest or at his side, he presents the least chance for variation in the degree of extension of the back, in the amount of pelvic inclination, or twisting of the trunk. At the same time, a base line for the localization scheme becomes available: the flat top of the treatment couch. All irradiation prescriptions contain, as one of the co-ordinates of beam direction, the distance from the plane of the couch top to the central ray of the horizontal beam. The light beam of the localizer is, of course, coincident with the radiation beam.

A second co-ordinate is the distance, cephalad or caudad, from some prominent landmark such as the angle of Louis, the pubic symphysis, or some other reference point. The third co-ordinate is the distance laterally from the midline.

When a patient has been accepted for radiation therapy on the Theratron, the fol-

lowing steps are carried out prior to treatment. Lateral and anteroposterior roentgenograms are taken with the patient in the standard position, a "ruler" radiograph is made, the volume to be treated is identified and located in terms of the three co-ordinates, the field size is selected, and the dose is prescribed. At the first treatment session, a lateral radiograph is obtained with the cobalt-60 gamma rays. This is done to confirm the accuracy of the localization procedure. In the material to follow, each of these steps with the exception of the dosage calculation will be discussed in detail.

Although this scheme of localization was developed around the use of a Hodges (1) pelvimetry table (Fig. 1), this paper will present the method as it can be used with a standard radiographic table for the anteroposterior view, supplemented by a mobile radiographic unit for the lateral view. The use of a simple cassette holder for the lateral view is desirable, as two films must be exposed without altering the position of the horizontal x-ray beam. The second of these, taken after the patient has been removed from the table, is of a special ruler, standing vertically on the table top in a position corresponding to the sagittal plane of interest (Figs. 1 and 2). The cassette holder should have some type of opaque reference marks near its center so that, when these marks on the two developed lateral films are superimposed, the distance from the table top to the point of interest in the patient can be read directly from the "ruler" radiograph (Figs. 3 and 4). The latter can also be used to measure the size and distances of visualized parts that lie in the same plane as that of interest.

The ruler, which can be made from either wood or polystyrene, has a series of 35 holes,

<sup>1</sup> From the Alice Crocker Lloyd Radiation Therapy Center, Department of Radiology, The University of Michigan Medical Center, Ann Arbor, Mich. This work was aided in part by A. E. C. Contract No. AT-(11-1)-245. Accepted for publication in December 1958.

<sup>2</sup> Now at University Hospitals, Iowa City, Iowa

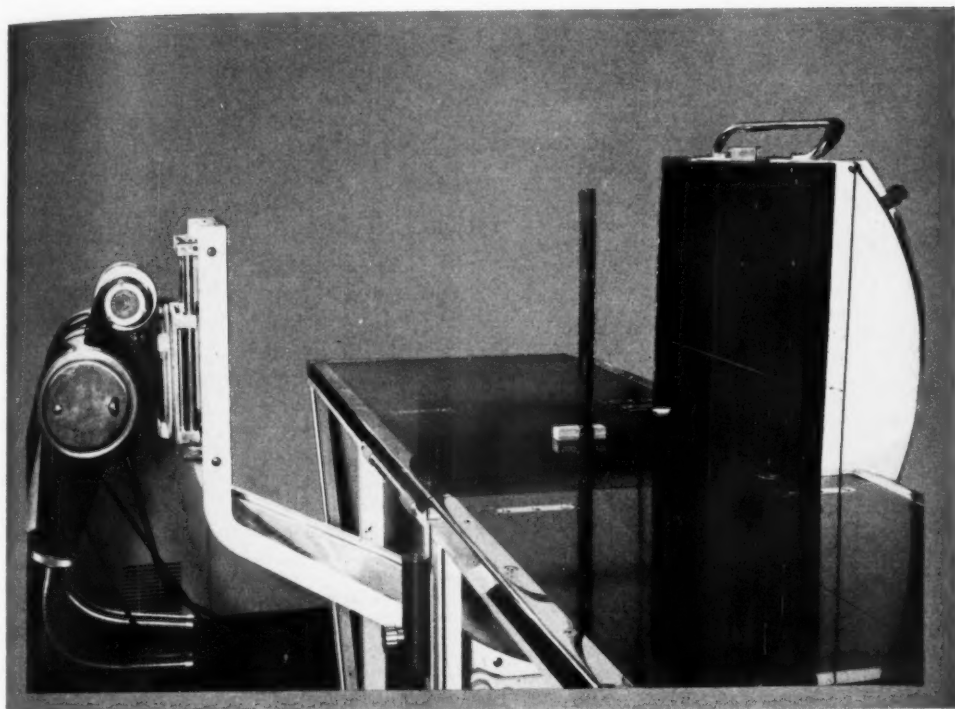
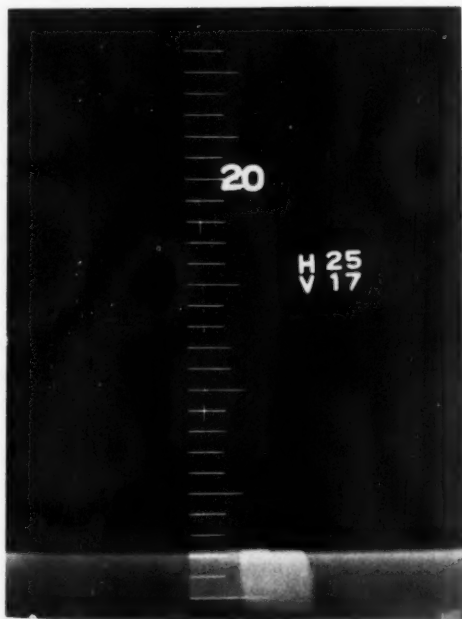


Fig. 1. Hodges pelvimetry table in position for lateral radiography, showing centimeter scale in position for making "ruler" radiograph. For the anteroposterior film, the x-ray tube, cassette holder, and intervening yoke rotate  $90^\circ$  as a fixed assembly without disturbing the position of the patient.



0.041 in. in diameter, drilled 1 cm. apart, perpendicular to its long axis. In each hole is glued a piece of No. 18 B and S gauge copper wire; every fifth wire is longer than the other four.

For the localization study, the patient is placed on the localization table, lying supine on a foam-rubber pad of the same thickness as the one on the treatment couch. His arms are either at his side or crossed on his chest. With the aid of the information gained from previous clinical and radiographic examinations, the approximate location of the lesion is centered on the anteroposterior and lateral films. The position of the patient is not altered be-

Fig. 2. Radiograph of the centimeter rule placed in the position of the sagittal plane of the patient (see Fig. 1). Note the opaque reference marks. The position of the central ray is found at the intersection of a line connecting the marks on each side of the scale with a vertical line connecting the reference marks at the 9- and 18-cm. lines of the scale. This would place the central ray at about 13.5 cm. above the table.

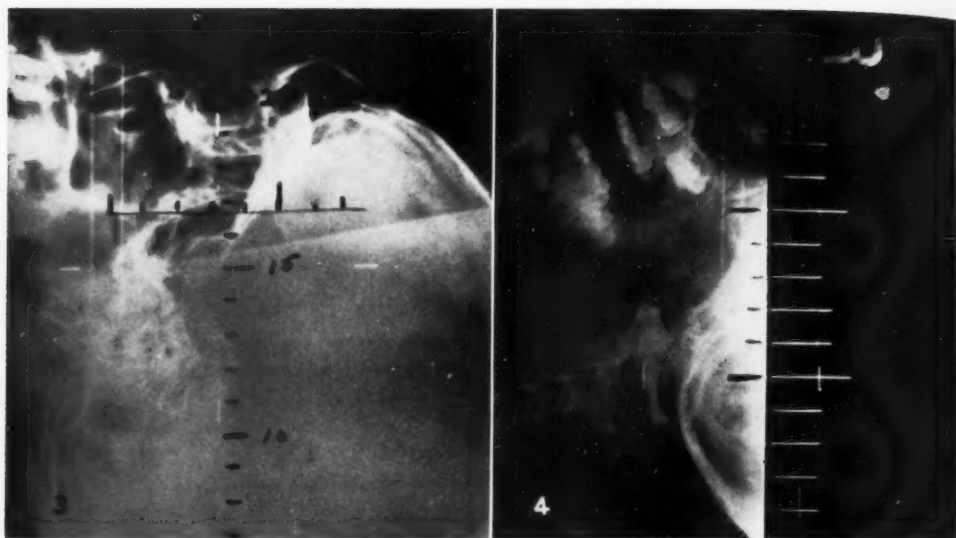


Fig. 3. Lateral localization film of a patient with a pituitary tumor. Note the four opaque reference marks which define the position of the central ray. The scale of the "ruler" radiograph has been transferred to the film. This scale is also used to determine the second co-ordinate; in this case it may be chosen as 3 cm. cephalad to the external auditory canal plane. The first co-ordinate, distance above the table, would probably be taken as 15-cm.

Fig. 4. Lateral localization film of patient with nasopharyngeal neoplasm. For purpose of demonstration, the "ruler" radiograph was placed alongside the radiograph so that a line connecting its horizontal reference marks falls on the horizontal reference marks of the former; in practice the reference marks are superimposed and the scale is transferred.

tween the taking of these two views. If rotation therapy is to be used, a contour of the patient is obtained by extending a piece of wire solder from one side at table-top level around the body surface in the center of the treatment field to the table top on the other side. The wire is then laid gently on a large piece of paper on which the outline is traced. By means of a standard-type body caliper the distance from the table top to the anterior part of the patient's body is determined at the level of the contour, and a lateral measurement is taken with the caliper in the same plane. These two dimensions are necessary for locating the contour drawing with respect to a line representing the table top.

After the contour has been drawn, the patient is taken from the table and the ruler is placed upon it, vertically, parallel to the cassette, intersecting the central ray of the horizontal beam at the same distance from the cassette holder as estimated for the tumor in the lateral film (Fig. 1). The second lateral film, the "ruler" radio-

graph, is made with the same target-to-film distance as the first lateral view (Fig. 2).

In order to calculate the treatment factors and to position the patient correctly for each treatment, three mutually perpendicular co-ordinates must be defined, with the Theratron table top as a plane of reference. The first co-ordinate is the vertical distance in centimeters measured upward from the table top to the horizontal central ray. This is always expressed as a positive number. The second co-ordinate is the distance, in centimeters, measured cephalad (positive) or caudad (negative) from some bony or other definitive landmark on the anterior or lateral surface of the patient's body or head, such as the pubic symphysis, the angle of Louis, the external canthus, etc., or from the vertical wires (defining the transverse plane through the two external auditory canals) of the head-holder to be described below. The third co-ordinate is the distance in centimeters of the lesion from the midline of the body to the right (negative) or left (positive).



Fig. 5. Patient in head-holder on the Hodges pelvimetry table in position to obtain the lateral localization film. The plastic ear plugs extend into the external auditory canals. The intersection of the white lines on the grid cover localize the central ray. The grid has been moved in toward the patient in contact with the shoulder.

The accuracy of this method of localization is verified by obtaining localization radiographs with the cobalt-60 treatment beam as well as by clinical and roentgen manifestations of regression of the neoplasm. The use of Eastman Industrial AA film in a cassette which has lead intensifying screens produces helpful check films. The front screen is 0.005 in. thick and the back screen is 0.01 in. thick; both are mounted on Bristol board. Exposure times for an exposure dose rate of 50 r per minute at the source-to-skin distance range from six to fifteen seconds depending on the thickness of the body part. The cobalt-60 radiographs are particularly useful when the lesions are located about the head and neck, but have also been of some assistance in demonstrating the location of treatment fields in the chest or pelvis. They have verified the accuracy of the procedure and in a few cases have shown where minor adjustment was needed in field size or position. Such adjustment is to be regarded as constituting a revision of the original judgment of location or size of the pertinent

volume rather than as indicative of an error of the method.

#### EXAMPLES OF APPLICATION OF THE SYSTEM

In the material that follows, attention will be directed toward the application of the localization scheme to several typical treatment sites.

*I. Head and Neck:* In the treatment of a lesion located either in the head or neck, a special head-holder is used both for localization and for the entire series of treatments. This device (Figs. 5 and 6) has been designed to immobilize the head during treatment. With the patient on his back, the ear plugs are introduced into the external auditory canals. This is accomplished by raising or lowering the device to the level of the canals and then advancing the plugs slowly into place by turning the crank in the appropriate direction. Wires embedded in plastic extend vertically from the center of the outer ends of the ear plugs, defining the transverse plane through the external auditory canals and acting as a reference in determining the distance along



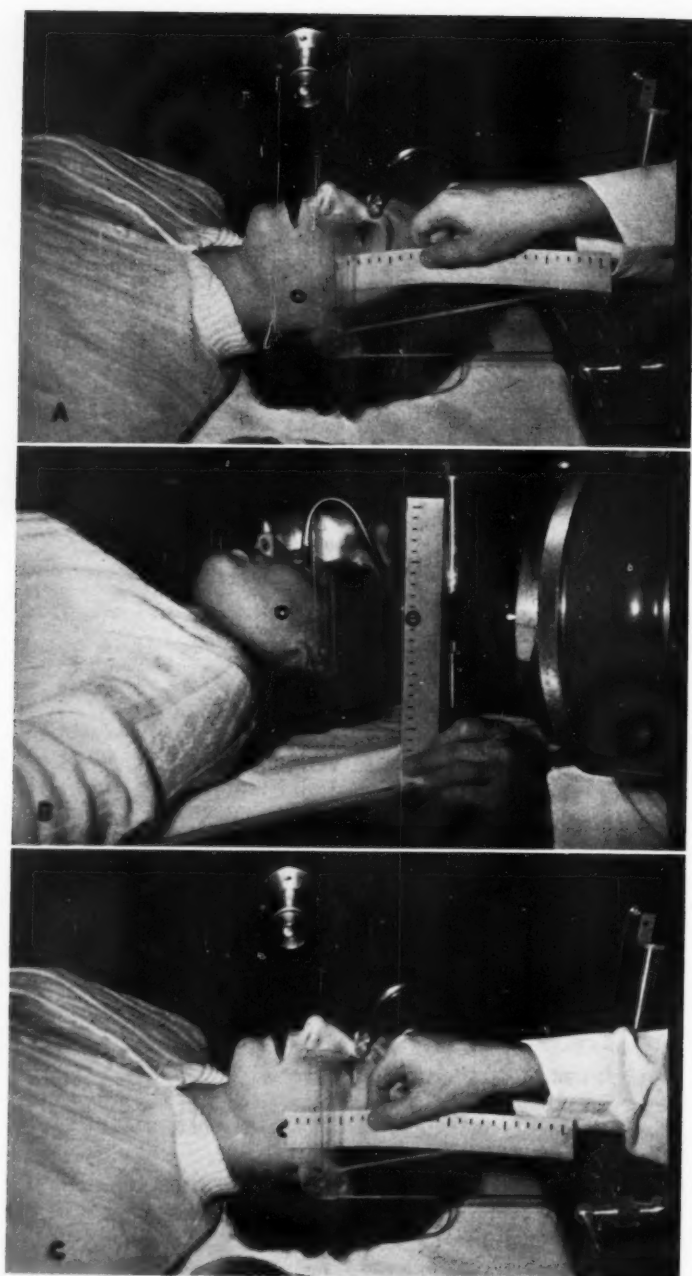


Fig. 6. Set-up for an oral lesion to be treated by lateral fields. The central ray is directed horizontally. The black circle represents the point of entrance of the central ray, which in practice is projected on the skin as a cross hair in the light-localizer beam.

A. Orientation of the head is fixed by the distance between the vertical reference wires (transverse plane through the external auditory canals) and the external canthus.

[For B and C see opposite page]

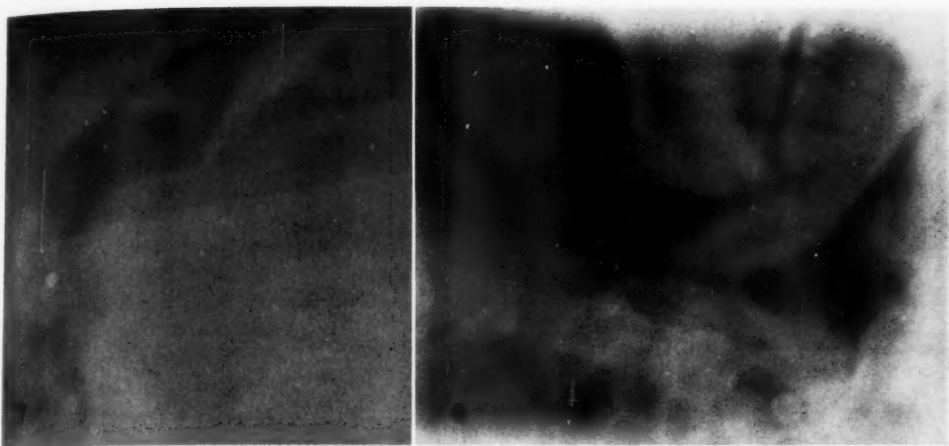


Fig. 7. Cobalt-60 radiograph to verify positioning for treatment of the pituitary tumor shown in Figure 3, the co-ordinates having been determined by pretreatment localization filming. The sella turcica is partly outlined by the air in the sphenoid sinus. Ear plug of the head-holder in the external auditory canal is visible.

Fig. 8. Cobalt-60 radiograph showing position of the treatment field for a patient with a lesion in the region of the tonsillar pillars and cervical metastases. Ear plug of head-holder is visible in lower right corner.

the second co-ordinate. The curved plastic rod, clamped against the glabella after the ear plugs are in place, prevents rotational motion of the head. The distance from the vertical wire to the external canthus establishes a fixed position of the head, which can be reproduced easily day after day (Fig. 6, A). When the lateral roentgenogram is made, the central ray from the tube is directed toward the center of the lesion, as approximately determined from earlier diagnostic films and clinical findings. The value of the first co-ordinate, the table top to central ray distance, is determined by the superposition of the cassette marks on the film of the "ruler" and the same marks on the lateral film of the patient (Fig. 4). The point of intersection of the image (or location) of the lesion with the image of the ruler is the distance, measured with the "ruler" radiograph, from the table top to the lesion. The value of the second co-ordinate is obtained by measuring with the "ruler" radiograph the distance to the

lesion from a line which can be drawn on the film approximately halfway between and parallel to the two images of the vertical wires<sup>2</sup> (Fig. 3). The value of the third co-ordinate is obtained from examination of the anteroposterior film. In the many cases in which the lesion is located in the midline, this third co-ordinate has a value of zero.

For the treatment set-up, an ordinary ruler is held parallel to the long axis of the patient and to the table top; the distance

<sup>2</sup> The 2 vertical wires mark the transverse plane through the external auditory canals. Usually this plane will not be along the central ray of the horizontal x-ray tube and the wires will not be superimposed on the film. The exact position of this plane, from which the second co-ordinate is measured, may be found by the expression  $Z = [WU/2(FF-H)]$ , where  $W$  is the distance in centimeters between the vertical wires of the head-holder,  $U$  is the displacement, in centimeters, of the image of the wire nearest to the film from the central ray intersection of the film,  $FF$  is focal spot-to-film distance in centimeters, and  $H$  is the distance in centimeters from the midsagittal plane of the head to the film.  $Z$  is the distance in centimeters from the image of the near wire (sharp image) toward the image of the wire most distant from the film and locates the zero plane.

B. The distance between the table top and the horizontal central ray (first co-ordinate) is set as determined by pretreatment localization filming. (The black circle on the ruler represents the cross hair projected on the ruler by the light localizer.)

C. The second co-ordinate, the distance between the desired point of entrance into the lesion of the central ray and the vertical reference wires, is set by moving the table in the cephalocaudal axis.



Fig. 9. Lateral localization film of patient with carcinoma of the esophagus. The scale of the "ruler" radiograph has been transferred to this film. The anterior chest wall is visualized to improved advantage by a midline lead strip, and at the lesion level is about 23 cm. above the table top. The center of rotation was chosen at 11.5 cm. above the table top (first co-ordinate), at 6 cm. caudad to the angle of Louis (second co-ordinate), and at zero value for the third co-ordinate (midline).

Fig. 10. Lateral localization film of patient with bladder tumor following instillation of a small volume of 30 per cent Urokon. The relationship to the table top and the symphysis pubis is shown. The posterior margin of the bladder is 10.5 cm. above the table top.

from the nearer vertical wire of the head-holder to the cross hair of the horizontally directed light-localizer beam is adjusted to equal the second co-ordinate distance (Fig. 6, C). With the light beam still horizontal, the table height (first co-ordinate) (Fig. 6, B), as well as the field size, can be adjusted. The Theratron is next rotated to the  $0^\circ$  position (beam vertically downward), and the third co-ordinate is adjusted by measuring the distance from the patient's midline to the central cross hair of the light beam. The verification cobalt-60 radiograph is made after the first treatment with the cobalt-60 beam in the horizontal ( $90^\circ$ ) position (Figs. 7 and 8). The radiographic exposure is not counted in the treatment time.

For lesions in the neck the head-holder has proved useful in maintaining a constant degree of extension of the neck on each day of treatment.

**II. Chest:** For planning treatment of a lesion located in the chest it is helpful to know the location of the esophagus. The localization anteroposterior and lateral films are made during normal respiration with the patient in the standard position, with the arms at the sides, as during treatment, and with a thick barium mixture in the esophagus. The air within the larynx, trachea, and coryna usually permits identification of these structures. In an occasional postoperative thoracotomy case, the tumor site is localized by silver clips.

The "ruler" radiograph is obtained in the usual manner and is used to measure the height of the pertinent structure above the table top. If rotational techniques are to be employed, a transverse plane contour, including the arms, is obtained with the use of the wire solder. The center of rotation, expressed in terms of the three co-

ordinates, is determined from these films and the contour; the dosage distribution is computed according to the method described by Braestrup and Mooney (2). Figure 9 shows the lateral localization film of a patient with carcinoma of the esophagus. The lesion is 11.5 cm. above the table top, the apex of the contour is about 23 cm., and the spinal cord about 6.5 cm. above the table top. The anterior chest wall is more easily identified on the lateral film if a lead strip is placed along the midline of the chest and a wedge filter is used.

A cobalt-60 radiograph is only occasionally helpful for chest lesions; the tracheal air gives good contrast with the other tissues. The use of the usual radiographic contrast media is valueless at the high energy of the gamma rays.

**III. Pelvis:** Localization studies for a patient with a carcinoma of the urinary bladder include the use of 5 to 10 c.c. of 30 per cent Urokon instilled into the empty bladder. This volume of contrast material does not distend the bladder and shows its position in relation to the table top, the symphysis pubis, and the anterior abdominal wall (Fig. 10). The patient empties his bladder prior to each irradiation so that the volume will be small, as during exposure of the localization film. For a rotational technic a transverse plane contour is obtained in the usual fashion. A center of rotation, defined in terms of the three co-ordinates, is determined from the localization films. We have found it useful to employ for the first co-ordinate (distance from table top to horizontal central ray) a value of 1.5 cm. plus the distance from the table top to the posterior extremity of the opaque bladder shadow. The second co-ordinate is obtained from the lateral localization film with the "ruler" radiograph measuring the distance from the symphysis pubis to the center of the bladder shadow (Fig. 10). For the rotational technic a 220° anterior arc (from 250° to 110°) is used.

It is of interest to note the rather wide variation in the distance from the table top

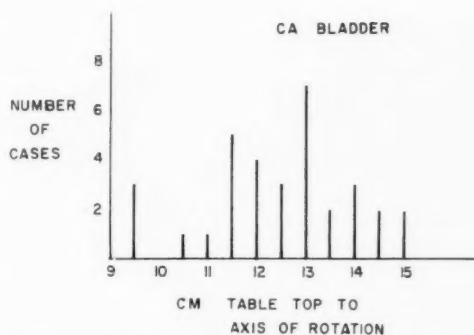


Fig. 11. Variation in distance between axis of rotation and table top (equals distance from table top to posterior extremity of the bladder plus 1.5 cm.) in 33 patients with carcinoma of the bladder.

to the posterior extremity of the bladder: 8 to 13.5 cm. in a group of 33 patients. The variation in distance of the axis of rotation to the table top becomes 9.5 to 15 cm. when the 1.5 cm. is added (Fig. 11).

For irradiation of the female pelvis in cases of uterine neoplasm, the localization films can be helpful in various ways. For determining the position of the cervix, the "ruler" radiograph measures the distance from an opaque obturator appropriately positioned in the vaginal apex to the table top. The correct cephalo-caudad position for the pelvic fields in relation to the symphysis pubis and the sacral promontory may be readily determined from the lateral localization film in conjunction with the "ruler" radiograph. Since we have adopted the practice of treating pelvic cases with the patient in the supine position for both the anterior and posterior fields (the Theratron head is positioned below the table top for irradiation of the posterior fields), the determined cephalo-caudad orientation applies to both. Furthermore, rotation of the pelvis is avoided and there is no change in the thickness of the part.

This system of localization and beam direction is applicable to lesions within the abdomen either by identification of tumor site with silver clips at operation or by reference to radiographically visible landmarks such as lower ribs, vertebrae, or the iliac crest.

## SUMMARY

1. A system for lesion localization and beam direction which is convenient and adaptable to a variety of clinical situations is presented.

2. Preliminary anteroposterior and lateral radiographs are made with incorporated reference markers. A special "ruler" radiograph is obtained for direct film measurements.

3. The lesion is located in terms of three rectangular co-ordinates which are referred to (a) the top of the treatment couch, (b) certain anatomical landmarks or the transverse plane through the external audi-

tory canals, and (c) the midline of the patient's body.

4. Cobalt-60 radiographs are used for verification of localization.

5. The system provides for reproducibility of lesion localization and beam direction daily during the course of prolonged radiation therapy.

University Hospitals  
Iowa City, Iowa

## REFERENCES

1. HODGES, P. C., AND NICHOLS, R. L.: Orthographic Pelvimetry. *Radiology* **53**: 238-246, August 1949.
2. BRAESTRUP, C. B., AND MOONEY, R. T.: Physical Aspects of Rotating Telecobalt Equipment. *Radiology* **64**: 17-27, January 1955.

## SUMMARIO IN INTERLINGUA

## Un Schema de Location pro le Planation de Radiotherapia con le Theratron

Es presentate un systema pro le location del lesion e le direction del fasce, le qual es practic e adaptable a un varietate de situationes clinic. Radiographias anteroposterior e lateral con le incorporation de marcas de referentia es facite como mesura preliminar. Un special "radiogramma-regula" es obtenite pro le uso in mesurationes de pellicula directe. Le lesion es locate con respecto a tres coordinatas rectangular que se refere a (1) le capite del lecto de tractamento, (2) certe punctos de

identification anatomic o—in le caso de therapia al capite e al collo—le plano transverse que passa per le externe canales auditori, e (3) le linea central in le corpore del patiente. Radiogrammas a cobalt-60 es usate pro verificar le location. Le systema permette le reproduction diurne del location del lesion e del direction del fasce durante prolongate therapia de irradiation.

Es presentate exemplos del application de iste systema a lesiones in capite e collo, thorace, e pelve.





# Fatal Venous Intravasation of Barium During a Barium Enema<sup>1</sup>

LEE S. ROSENBERG, M.D., and ARCHIE FINE, M.D.

THE BARIUM ENEMA examination is not always without risk. Once in a while a serious and occasionally even a fatal accident may occur as a result of this procedure. The following case represents an exceedingly unusual complication, in which the contrast medium in some unexplained manner entered the venous system and caused sudden death.

## CASE REPORT

A 73-year-old white woman was admitted to the Jewish Hospital on April 9, 1952, in a confused state. The history, obtained from relatives, indicated that one month prior to admission she had been studied at another hospital for about a week. A mass in the right lower abdominal quadrant had been found. Following a dilatation and curettage, a diagnosis of uterine fibroids had been made. After discharge from the hospital, the patient ran a febrile course, with a daily temperature elevation to 102°, and lost about ten pounds in weight. For these reasons she was admitted for study at our hospital.

Physical examination revealed an emaciated, chronically ill, irrational, elderly white female. The chest was clear. A large, firm, smoothly outlined mass was felt in the right lower abdomen. Pelvic examination showed the cervix to be normal. The uterus was thought to be greatly enlarged, and was continuous with the lower abdominal mass. Rectal examination demonstrated a small hemorrhoidal tag, but no other hemorrhoids were felt and no intrinsic mass was palpable. Brown stool was noted on the gloved finger. No sigmoidoscopy was done.

Roentgen examination of the chest disclosed moderate cardiac enlargement and evidence of a small amount of fluid at the left base. A plain film of the abdomen showed a large soft-tissue mass in the right lower quadrant and pelvis. Films of the bony structures revealed severe osteoporosis, with partial collapse of the bodies of the eleventh and twelfth dorsal and the second lumbar vertebrae, and destructive lesions in the ribs. The findings were interpreted as possibly representing metastases or multiple myeloma.

It was decided to do a barium enema examination in order to study the relationship of the mass to the colon. The patient was quite disoriented on her arrival in the X-Ray Department for this procedure. A Bardex balloon catheter was inserted in the rec-



Fig. 1. Film of the abdomen taken immediately postmortem. Barium is seen in the perirectal tissues and in the inferior vena cava and some of its branches. Details of the veins of the right kidney are shown with striking clarity. Perirectal gas is noted on the right. There is a soft-tissue mass in the right lower quadrant of the abdomen and pelvis. Destructive processes in the ribs and vertebrae are present but are not well demonstrated in this reproduction.

tum by the technician, but the patient immediately expelled it. The catheter was reinserted by one of us (A. F.) and under fluoroscopic guidance the bulb was filled with air. It did not appear that an excessive amount of air was used, and the patient gave no sign of particular pain or discomfort. The barium suspension was then instilled. This seemed to be entering the rectum in the usual fashion, when suddenly some of the barium appeared to channel in multiple directions and then to sweep cephalad. The enema was instantly stopped. Immediate fluoroscopy of the chest showed a large amount of opaque material in the right side of the heart and in the pulmonary arteries. The patient stopped breathing and died within a minute or two of the accident. Attempts were made to resuscitate her with artificial respiration and intracardiac epinephrine, but these measures failed.

Roentgenograms of the abdomen and chest were

<sup>1</sup> From the Department of Radiology, The Jewish Hospital, Cincinnati, Ohio. Accepted for publication in December 1958.



Fig. 2. Postmortem chest film. Dense contrast medium is seen in the right side of the heart and in the pulmonary arterial system.



Fig. 3. Barium enema study of another patient, who suffered a rectal tear during the procedure. A pocket of contrast medium outside of the rectal lumen is demonstrated.

made immediately after death. The film of the abdomen (Fig. 1) showed barium in the rectal area, in the inferior vena cava, and in the hepatic and renal venous systems. The barium in the rectal region was irregularly dispersed, and appeared to lie partially or entirely in the perirectal space. A shadow of perirectal gas was noted on the right. A large soft-tissue mass was seen in the right lower abdominal quadrant and pelvis. In the chest roentgeno-

gram (Fig. 2), the contrast medium was seen in the right side of the heart and in the pulmonary arteries.

A postmortem digital rectal examination revealed a small amount of mucus in the rectum, but no masses or tears could be felt. Unfortunately, permission for autopsy could not be obtained.

#### COMMENT

One other case similar to ours has been reported by Roman, Wagner, and Steinbach (1). Their patient, like ours, was an elderly female who died within four or five minutes after a barium enema, with massive barium embolism. A Bardex balloon catheter was also used. An autopsy was performed in this case, and no cause could be found for the entry of the barium into the venous system. In particular, no tears were observed in the rectum or sigmoid, and there was no evidence of any pathological abnormality in this area.

In our case also, the cause of the accident is not apparent. No extraordinary inci-

dent occurred during the preparation of the enema or in setting up the patient for the examination. However, a study of the postmortem films showed very little, if any, of the barium actually within the rectal lumen. The distribution of the barium in this region was ragged and irregular, and we believe that most of it in some manner

entered the perirectal tissues and then broke into a hemorrhoidal vein. The mechanism by which this took place is not clear. A pathological lesion may have been present, but there is no direct evidence as to its nature. The mass in the right lower quadrant of the abdomen was located anteriorly and did not seem to be related to the rectum. The destructive lesions in the bony structures may have been secondary to a neoplasm in the rectum or rectosigmoid, but without an autopsy we can only speculate concerning this possibility.

The question arises as to whether trauma to the rectum by the inflated balloon catheter may have been responsible for the accident. While we cannot answer this question, we recently had another case which may shed some light on this subject. This second patient, also an elderly female, suffered a definite tear of the rectum during administration of a barium enema, apparently the result of inflation of the balloon catheter. The trauma was later proved by sigmoidoscopy. In Figure 3, films of the rectal region of this patient are shown before and after evacuation.

The irregular pattern of barium outside the rectal wall is clearly demonstrated in the post-evacuation film. Recovery was uneventful, and there was no venous intravasation.

Considerable caution should be used during the inflation of a balloon catheter in the rectum. When it is necessary to use this type of instrument, the possibility of damage to the rectal wall should be constantly kept in mind.

#### SUMMARY

A most unusual type of fatal complication of a barium enema examination is reported. The contrast medium, in some unexplained manner, entered the venous system of the patient and caused immediate death.

NOTE: Acknowledgment is made to Drs. Benjamin Felson and Harold N. Margolin for their kind assistance in helping us prepare this report.

The Jewish Hospital  
Cincinnati 29, Ohio

#### REFERENCE

1. ROMAN, P. W., WAGNER, J. H., AND STEINBACH, S. H.: Massive Fatal Embolism During Barium Enema Study. *Radiology* 59: 190-192, August 1952.

#### SUMMARY IN INTERLINGUA

##### Intravasation Venose de Barium post Clyster de Barium, con Exito Mortal

Es reportate le morte de un femina de 73 annos de etate durante le administration de barium con un catheter ballonate Bardex in preparation pro le examine roentgenographic. Le substantia de contrasto pareva entrar in le recto in le maniera usual, quando subitement illo surgeva in avant in le direction del capite del patiente via un multiplicitate de canales. Le clyster esseva interrupte instantaneamente. Le immediate examine fluoroscopic del thorace revelava le presentia de un grande quantitate del materia opac in le parte dextere del corde e in le arterias pulmonar. Le patiente moriva intra un a duo minutas post le accidente. Roentgenogrammas effectuate immediate-

mente post morte monstrava barium in le area rectal, in le vena cave inferior, e in le systemas venose de hepate e ren. Nulle explication del accidente esseva evidente. Un studio del pelliculas monstrava pauc o nulle barium intra le passage rectal. Es opinate que le plus grande parte de illo entrava in un maniera o un altere in le histos perirectal e irrumpeva allora in un vena hemorrhoidal.

Es signalate le possibilitate que trauma causate in le recto per le inflationate catheter ballonate esseva responsabile pro le occurrentia. Es mentionate un secunde caso in que un ruptura in le recto esseva demonstrate post le inflation de un catheter ballonate, sed nulle intravasation sequeva.

# Improvement of Diagnostic Value of Photofluorographic Films by Electronic Means

## A Preliminary Report<sup>1</sup>

MYRON FORMAN, M.D., ANTHONY BOREADIS BORDEN, M.D., AND I. GERSHON-COHEN, M.D.

**B**ECAUSE OF THE difficulty of interpretation of photofluorographic films resulting from their small size and poor contrast, their use has been necessarily limited in fields other than routine chest examinations. Investigation, therefore, of the possible application of the Philco Exicon Contrast Enhancer (1-3) was undertaken in an attempt to improve by electronic

tained in this initial study have been encouraging. In a high percentage of cases we were able to make an accurate diagnosis, as compared with regular films. This brings well within the realm of possibility a method either for use in routine study of the great number of cases encountered in large hospitals and teaching centers or for mass surveys. Figures 1 and 2 demon-

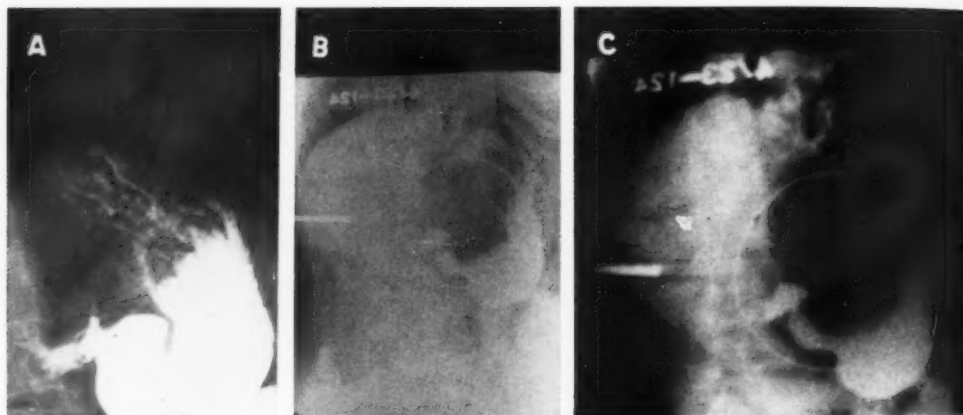


Fig. 1. A. Regular film demonstrating large hiatal hernia.  
B. 70-mm. Odelca film also shows the hiatal hernia. Note general poor contrast and grayness.  
C. Same 70-mm. film, viewed on the Exicon Contrast Enhancer. Although much is lost in reproduction, there is obvious, great improvement in contrast. The hernia is easily seen.

means the diagnostic quality of photofluorograms. The Exicon is, in essence, a closed television circuit which makes it possible to enlarge the x-ray image to approximately life size and also to change or intensify slight shadings of contrast, so that considerable improvement in the visible details results.

As a first step in this project a series of 70 patients chosen at random were submitted to gastrointestinal examinations both by conventional means and by photofluorographic technic. The results ob-

strate the surprisingly good detail made visible in the small photofluorographic films by the Exicon Contrast Enhancer.

We envisage the application of this technic to other parts of the gastrointestinal tract and chest, and to angiographic studies. As the scope of our investigation enlarges, more detailed reports will be submitted.

It is felt that the application of the Exicon may well broaden the use of the photofluorographic technic because of the following advantages:

<sup>1</sup> From the Department of Radiology, Albert Einstein Medical Center, Northern Division, Philadelphia 41, Penna. Accepted for publication in December 1958.

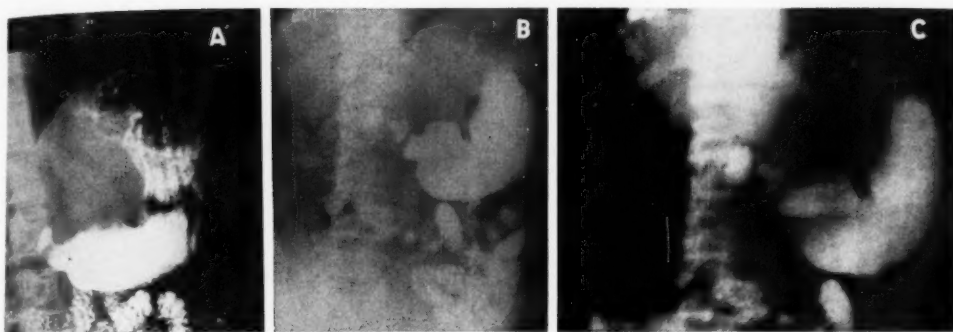


Fig. 2. A. Representative film from regular gastrointestinal study. A large duodenal ulcer is not demonstrated because of poor filling of cap.  
B. 70-mm. Odelca film shows the ulcer. Note poor contrast.  
C. Same 70-mm. film, seen on the Exicon. Note greatly enhanced visibility of the ulcer.

- (1) The speed of the examination is greatly increased.
- (2) The cost of film is radically reduced.
- (3) Detail may be improved in some cases over that of regular films. Films otherwise valueless may prove useful because of the enhanced contrast.
- (4) Fluoroscopy may become needless and therefore be eliminated except in difficult cases.
- (5) Use of the Exicon Enhancer is rapid and simple.

#### SUMMARY

A series of 70 upper gastrointestinal examinations were made by photofluorographic technic and viewed by means of an

electronic Contrast Enhancer. The preliminary results seem to indicate that the improvement in detail obtainable by this technic may make possible the use of this method for routine gastrointestinal work and for mass surveys.

Albert Einstein Medical Center, Northern Division  
York and Tabor Roads  
Philadelphia 41, Penna.

#### REFERENCES

1. FISHER, J. F., AND GERSHON-COHEN, J.: Television Techniques for Contrast Enhancement and Color Translation of Roentgenograms. *Am. J. Roentgenol.* **79**: 342-347, February 1958.
2. FISHER, J. F., AND GERSHON-COHEN, J.: Color Translation and Contrast Enhancement of Roentgenograms by Television Techniques. *J. Albert Einstein M. Center* **5**: 166-176, June 1957.
3. GERSHON-COHEN, J., AND FISHER, J. F.: Contrast Enhancement with Television Technics: Gallbladder Lesions. *Radiology* **70**: 390-391, March 1958.

#### SUMMARIO IN INTERLINGUA

#### Melioration del Valor Diagnostic de Pelliculas Photofluorographic per Medios Electronic: Reporto Preliminari

Un serie de 70 patientes, seligite al hasardo, esseva subijcte a examines gastrointestinal per medios conventional e etiam per un technica photofluorographic. Le photofluorogrammas esseva inspicite subsequentemente per medio de un electronic Accentuator de Contrasto. Le resultados preliminar pare indicar que le melioration de detalio que es effectuable per iste technica va render possibile le uso

de illo in studios gastrointestinal rutinari e etiam in enquetes in massa.

Es presentate illustrationes pro duo del casos. Le prime de illos es un caso de hernia hiatal. In le secunde il se tracta de un grande ulcere duodenal non demonstrabile in un pellicula representative a causa de defectos de replenation sed clarmente evidente in le uso del Accentuator de Contrasto.



## Cervicodorsal Diverticula of the Subarachnoid Space<sup>1</sup>

ROBERT SHAPIRO, M.D., and FRANKLIN ROBINSON, M.D.

LOCALIZED SACCULAR dilatations of the subarachnoid space overlying the lumbar nerve roots occur with moderate frequency (4). In the authors' experience, however, similar dilatations in the cervical and dorsal areas are relatively uncommon. The purpose of this paper is to report briefly 2 cases of asymptomatic diverticular extensions of the subarachnoid space overlying the eighth cervical nerve root and to indicate the roentgen findings which distinguish the entity from avulsion of the brachial plexus.

CASE I: H. B., a 38-year-old male, was hospitalized July 10, 1957, because of cervical, shoulder, and arm pain on the left side. One week prior to admission, he was physically jarred while driving his car which was struck in the rear by a truck. He experienced stiffness of the neck and pain in the left cervical region which radiated into the corresponding shoulder and arm. Pain was aggravated and particularly precipitated by turning the head and neck to the right. The patient complained of intermittent tingling and weakness of the left hand as well.

Physical examination revealed moderate tenderness over the left trapezius and supraclavicular and upper dorsal regions. Scalene tension tests on the left were positive. Passive neck rotation to the right and extension produced pain which was referred to the left arm and dorsal region. There was moderate restriction of active and passive cervical flexion. Good power was present in all four extremities without reflex abnormalities.

Roentgenograms of the cervical spine showed moderate narrowing of the intervertebral disk space between the fifth and sixth cervical vertebrae with spur formation. Myelography was essentially negative except for a small diverticulum of the right eighth cervical root (Fig. 1).

The clinical impression was musculoligamentous strain of the cervicodorsal region and the patient's symptoms subsided progressively with physiotherapy.

CASE II: G. R., a 43-year-old housewife, was admitted to the hospital on Sept. 22, 1957, with complaints of headache, convulsions, and weakness of the right arm. Six years prior to admission the



Fig. 1. Subarachnoid diverticulum of right eighth cervical root.

patient had a hysterectomy and shortly thereafter became aware of some weakness of the right arm and headache which remained rather persistent to the time of hospitalization.

General clinical and neurological examinations were essentially negative except for hypertension (blood pressure 170/105 Hg).

Conventional roentgenograms of the cervical spine showed narrowing of the intervertebral disk space between C5 and C6 with osteophyte formation anteriorly and posteriorly at this level. There was posterior spur formation at C4-5 as well. Roentgen studies of the skull were normal.

Myelography demonstrated defects on the anterior aspect of the Pantopaque column at C4-5 and C5-6 corresponding to the sites of the posterior spurs. There was also a small diverticulum of the left eighth cervical nerve root (Fig. 2).

A cervical laminectomy was performed at C5-6 at

<sup>1</sup> From The Departments of Radiology and Neurosurgery, The Hospital of St. Raphael, New Haven, Conn. Accepted for publication in December 1958.



Fig. 2. Subarachnoid diverticulum of left eighth cervical root.

the site of the larger bony spur and nerve root decompression was carried out. No frank herniation of the intervertebral disk was noted. The patient was discharged from the hospital Oct. 7.

CASE III: F. G., a 33-year-old truck driver, was involved in a head-on collision June 5, 1955. There was transient loss of consciousness. On admission to the hospital he complained of pain in the left hip, and numbness and paralysis of the left upper extremity.

Physical examination revealed an irregular laceration of the left supra-orbital area and extensive lacerations over the left shoulder and hip. Neurological evaluation disclosed flaccid paralysis of the left upper extremity with accompanying loss of deep reflexes and diffuse sensory impairment.

Roentgenograms of the skull and pelvis were normal. A comminuted fracture of the left scapula was demonstrated. Films of the dorsal spine showed compression fractures of the bodies of the seventh and eighth thoracic vertebrae. Difficulty in voiding necessitated indwelling catheter drainage for five weeks until the slowly returning bladder function was restored. Lumbar puncture June 26, 1955, showed open manometrics. Cerebrospinal fluid protein was 70 mg. per cent. A myelogram at this time demon-



Fig. 3. Brachial plexus avulsion with extra-arachnoid collections of Pantopaque around sixth, seventh, and eighth left cervical roots.

strated multiple tears of the arachnoid membranes about the lower cervical nerve root sleeves with extravasation of Pantopaque characteristic of avulsion of the brachial plexus (Fig. 3). Motor function of the left arm and forearm did not improve appreciably over the next several months, although there was some recovery at the hand and wrist. One year later there was marked atrophy of the left deltoid with no active motion at the shoulder. There was also residual marked atrophy of the left biceps and triceps muscle groups with absence of tendon reflexes. The final diagnosis was flaccid paralysis of the left upper extremity secondary to avulsion of the fifth, sixth, seventh, and eighth cervical roots.

#### DISCUSSION

There should be little difficulty in the differential diagnosis between asymptomatic diverticular extensions of the suba-

rachnoid space and avulsion of the brachial plexus since the latter is accompanied by segmental motor and sensory deficits. Thus, upper brachial plexus injuries involving the fifth and sixth and occasionally the seventh cervical nerves are characterized by paralysis of the serratus magnus, levator scapulae, and rhomboid muscles. Lower brachial plexus injuries result in a sensory and motor deficit involving the eighth cervical, first thoracic, and occasionally the second thoracic nerves in association with a Horner's syndrome (1-3, 5-7).

Roentgenographically there is a distinct difference between the pockets found in avulsion and the normal saccular dilations of the cervical subarachnoid space. In the case of avulsion, the meningeal tear permits an irregular extradural extravasation of Pantopaque with jagged blunt margins. Localized subarachnoid diverticula,

on the other hand, are characterized by a smooth, delicately rounded outline continuous with the subarachnoid space.

Hospital of St. Raphael  
New Haven, Conn.

#### REFERENCES

1. JAEGER, R., AND WHITELEY, W. H.: Avulsion of Brachial Plexus. Report of Six Cases. *J.A.M.A.* **153**: 633-635, Oct. 31, 1953.
2. MURPHEY, F., HARTUNG, W., AND KIRKLIN, J. W.: Myelographic Demonstration of Avulsing Injury of the Brachial Plexus. *Am. J. Roentgenol.* **58**: 102-105, July 1947.
3. RAYLE, A. A., JR., GAY, B. B., JR., AND MEADORS, J. L.: The Myelogram in Avulsion of the Brachial Plexus. *Radiology* **65**: 65-71, July 1955.
4. TARLOV, I. M.: Perineurial Cysts of Spinal Nerve Roots. *Arch. Neurol. & Psychiat.* **40**: 1067-1074, December 1938.
5. TARLOV, I. M., AND DAY, R.: Myelography to Help Localize Traction Lesions of the Brachial Plexus. *Am. J. Surg.* **88**: 266-271, August 1954.
6. WHITE, J. C., AND HANELIN, J.: Myelographic Sign of Brachial Plexus Avulsion. *J. Bone & Joint Surg.* **36-A**: 113-118, January 1954.
7. WHITELEATHER, J. E.: Roentgen Demonstration of Cervical Nerve Root Avulsion. *Am. J. Roentgenol.* **72**: 1017-1022, December 1954.

#### SUMMARIO IN INTERLINGUA

##### Diverticulos Cervicodorsal del Spatio Subaracnoide

Iste articulo reporta brevemente 2 casos de extensiones diverticular del spatio subaracnoide jacente supra le octave radice de nervo cervical e 1 caso de avulsion del plexo brachial. Localisate dilatationes subaracnoide in iste areas es paucio commun.

Roentgenographicamente il existe un distincte differentia inter le tascas incontrate in avulsion e le normal dilatationes

saccular del spatio subaracnoide cervical. In casos de avulsion, le fissura meningee permette un irregular extravasation extradural de Pantopaque exhibiente obtuse margines dentate. Del altere latere, localisate diverticulos subaracnoide es characterisate per un lisie profilo que es delicatemente curvate e forma un continuitate con le spatio subaracnoide.



# Progressive Patient Care in Radiology<sup>1</sup>

JOHN D. REEVES, M.D.<sup>2</sup>

THOSE HOSPITALS which have not already done so will soon be adopting or adapting a program (1-4) of "progressive patient care" (PPC). This type of program provides for three zones within the hospital where care is tailored to the patient's needs as established by his physician. These three zones or areas have been described as: (a) *intensive-care* area for the seriously ill and for immediate postoperative care; (b) *intermediate-care* area for those who need present-day nursing attention; (c) *self-help* area for convalescents and others who may wish to take care of many of their own needs. By such zoning of patients, the progressive care plan will not only provide for better patient care but it should also ease the economic burden on the patient by relieving him of a share in the expense of services which he personally no longer needs.

At first sight, the division of a hospital into three PPC zones would seem to have little bearing on the practice of radiology. Patients receiving radiotherapy would probably be distributed throughout all three zones. Likewise, diagnostic radiology will need to be provided for patients from all three zones. In the small hospital with a small radiology department the problems of "progressive patient care" will probably be negligible. But, particularly in the large hospital with a large department of radiology, expert planning is necessary if the full medical and economic benefits of PPC are to be realized. This is particularly true if the philosophy of "progressive patient care" is extended and adapted specifically to radiology, and this specialty in turn is integrated with the overall planning for hospital and clinic patients.

To achieve the best in patient care as

well as economy, a department of radiology should be geographically located in the center of patient distribution; this principle is true regardless of the size of the hospital. A department of radiology added to one end of a hospital or a clinic will inevitably cause inconvenience and loss of time to both patients and referring physicians. The ideal department might be located not only in the horizontal geographical center but also in the vertical. For this reason, at least one excellently preplanned department is located in the center of the sixth floor of a twelve-story hospital (with a small clinic load). The location of radiologic facilities in the center of patient distribution is a sound principle for planning hospitals, regardless of size.

In juxtaposition to the ideal radiology department should be placed those clinical services most often in need of radiologic consultation. Thus, orthopedic surgery and urology would have priority locations next to radiology. Such services as dermatology and psychiatry can be located more distantly because their patients have less frequent need of x-ray study.

In planning the distribution of other services in relation to radiology, care must be taken to allow for future expansion of radiologic facilities in several directions. Certainly, radiology is one of the most rapidly growing medical specialties, and there is no evidence that it has yet reached its plateau of greatest potential. Recent surveys have shown that there is not only a continuing increase in the number of patients examined but also an increasing number of radiologic examinations per patient. Added to this is the increasing number of new and time-consuming examinations, such as angiocardigraphy,

<sup>1</sup> Accepted for publication in November 1958.

<sup>2</sup> Instructor in Radiology, Harvard Medical School; Associate Radiologist, Department of Radiology, Massachusetts General Hospital, Boston, Mass. Now at the J. Hillis Miller Health Center, University of Florida, Gainesville, Fla.

intravenous cholangiography, and many of the neuroradiologic procedures.

Within the department of radiology, the concept of "progressive patient care" can be adapted to great advantage for the patient and physician, and at the same time can improve the economics of operating a large department. PPC applied to diagnostic radiology might result in four main radiology patient areas: (a) Emergency Radiology, (b) Special Procedures, (c) In-Patient Area, and (d) Ambulatory Area. To give a visual image to the following discussion, let these four areas be considered as the four extremities of the letter "H," as shown in Figure 1.

#### EMERGENCY RADIOLOGY

Emergency radiology is a section where patients from the emergency ward and some from the *intensive-care area* would receive expeditious examination. Facilities should be provided for radiological studies of acute abdominal and chest diseases, as well as for trauma and fractures. Such an area could also incorporate an x-ray plaster-room for the reduction of those fractures which occur in patients who remain ambulatory.

A properly planned and integrated Emergency Radiology section would allow for the occasional absorption of emergency overloads into the remainder of the Radiology Department; such planning would be of paramount importance in the event of minor or major catastrophes. An additional advantage of integrated planning would be the availability of special equipment for special examinations. For example, a room designed for radiologic examination of the skull could be at the end of the emergency section, adjacent to the Special Procedures area, or *vice versa*, depending on the relative patient usage anticipated in the two sections.

In allocating space, equipment, and personnel for Emergency Radiology, planning must be on the basis of maximum anticipated patient loads. To use average loads as a basis for planning emergency

areas results, by definition, in less than "average" care at least half of the time. Aside from the desirable philosophy of always providing the best in medical care, there is the practical point that patients in emergency situations demand peak performance, and rightly so. In real emergencies, there is no adequate justification for avoidable delays or less than ideal care.

Emergency Radiology must be planned to take care of the acutely ill patient in reasonable comfort and in the shortest time compatible with reaching an accurate diagnosis. In a large general hospital with an active emergency service, this may imply from four to ten x-ray rooms in Emergency Radiology. By integration with the remainder of the department, some economy can be effected by utilizing these rooms for the examination of other patients when the emergency load is light. The primary planning, however, must be for emergencies, and, since emergencies cannot be scheduled as can other examinations, some economic inefficiency must be accepted if optimal medical efficiency is to be obtained.

#### SPECIAL PROCEDURES

The Special Procedures section would include rooms specially designed for neuroradiology, cardiovascular radiology, and special genitourinary studies. Most of these rooms would be designed as "clean" semioperative rooms, so that general anesthesia could be safely administered if needed. Many special procedures require equipment over and above special x-ray equipment; therefore, rooms must be larger than usual. In some Special Procedures sections additional provision must be made for such facilities as sterilizers, autoclaves, instrument storage, "scrub" sinks, and laboratories for special examinations.

Neuroradiology requires provision for cerebral angiography, pneumoencephalography, ventriculography, stereotactic procedures, and myelography. A special head stand and patient-supporting devices



are needed for pneumoencephalography and ventriculography; stereotactic instruments may be used in the same room. A cerebral laminagraphic device may be desirable. For cerebral angiography, a two-tube, biplane, rapid serialographic apparatus is needed. Depending on the patient-load distribution, the above facilities may be combined in one double-size room or placed in from one to three separate rooms. An additional fluoroscopic facility is needed for myelography; by today's standards this also implies the utilization of an image amplifier and cine-radiography, and, in a teaching hospital, television circuitry.

*Cardiovascular radiology* requires an extra large room set up for angiocardiology and cardiac catheterization. Angiocardiology calls for a rapid serialographic biplane facility of larger size and different design from that used in cerebral angiography. Cineradiography may also be important in certain situations. Cardiac catheterization today requires image amplification fluoroscopy, preferably with television monitoring. A laboratory of modest-size is needed, adjacent to the cardioradiology room, for blood sample analysis during catheterization. Aortography can usually be performed on the same apparatus as that used for angiocardiology. If much peripheral vascular surgery is anticipated, a special facility should be used for preoperative examination of the diseased vessels.

Special *genitourinary procedures* are those other than intravenous pyelography and simple cystography. In general, from one to three rooms would be set up with cystoscopic equipment for retrograde pyelography, urethrograms, and special cystograms such as stress incontinence studies.

Since all of these special procedures require expeditious radiologic handling, this area could ideally be joined to the emergency area, with space for darkroom facilities and film-viewing, as well as for radiologic consultations, provided at the junction of the two.

#### IN-PATIENT AREA

The In-Patient Area would be designed for seriously ill patients, many of whom would be in beds or on stretchers. For this section, x-ray rooms should be larger for ease in moving and examining patients. Doors should be wide enough and high enough to admit beds with orthopedic and other frames. Corridors should be extra wide to allow easy passage of beds. Special supervised bed and stretcher waiting space should be provided; sick patients should not be left waiting in crowded corridors used as general passageways.

The actual x-ray facilities provided in this area will depend to some extent on the relative proportion of in-patients to ambulatory patients. Provision will need to be made for intravenous pyelograms, intravenous cholangiograms, cholecystograms, gastrointestinal series, barium enemas, chest fluoroscopy, as well as skull, sinus, dental, and bone examinations.

#### AMBULATORY PATIENT AREA

The Ambulatory Patient Area would be designed with waiting rooms for clinic patients and for in-patients from the progressive patient care *self-help unit*. At the junction of the *Ambulatory* and *In-Patient Areas*, fluoroscopic facilities could be logically and economically designed to serve both groups, without the necessity for cross-traffic between the two. This feature is most helpful in handling large patient loads, and the lack of cross-traffic between bed and ambulatory patients is psychologically desirable from the patient's point of view. Overlap of other types of examination may be feasible: for example, rooms designed for intravenous pyelography might be used for in-patients in the morning and for ambulatory patients, by appointment, in the afternoon. Special joint facilities may be desirable for such services as fracture, cardiac, and genitourinary clinics.

#### DISCUSSION

An "H"-shaped department of radiology (Fig. 1) is only one of many possible

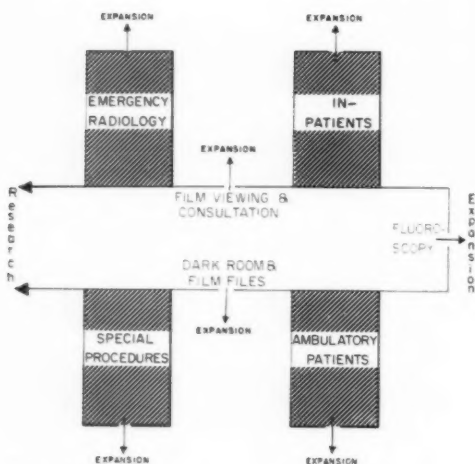


Fig. 1. One method of providing the four "progressive patient care" areas in radiology, with optimum zoning for various types of patient examinations and economic utilization of facilities common to more than one area.

solutions but, for purposes of discussion, we may consider the four radiologic progressive patient care areas to be distributed as described above, with emergency and special procedures areas on the left, and with ambulatory and in-patient areas on the right. The crossbar of the "H" would lend itself admirably to central facilities for darkrooms, film files, film viewing, and consultation. The radiologist would then be in the center of radiologic activity and, when needed, could move to any extremity of the "H" in the shortest time. This affords him an important strategic point of vantage.

The radiologic concept of a progressive patient care "H" department has additional advantages. The first is that there are six directions in which to expand. Thus, if the emergency load increases, the emergency radiology area could be extended. All limbs of the PPC "H" need not be the same length or size. They may be varied to suit the needs of a particular hospital or clinic. Thus, a hospital with a large clinic load might have a large ambulatory x-ray facility. This in turn could be modified to a double corridor system (Fig. 2) to accommodate two types of patients, or

to an "interleaving plan" (Fig. 3) wherein special x-ray facilities for special clinics are so placed as to join at the point where a particular type of facility is located. Many alternatives including the four radiologic progressive patient care areas are possible. Some of these might be visualized as "X"-shaped (rather than "H"-shaped), or "Y"- or "T"-shaped (no

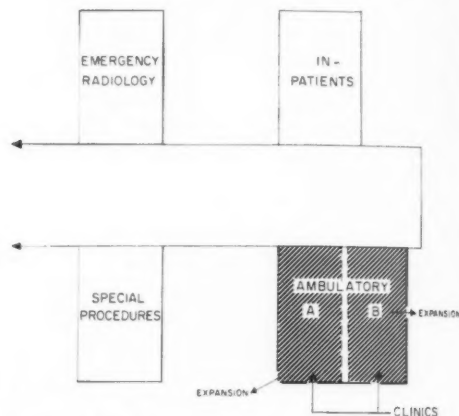


Fig. 2. The "H"-system modified by a double corridor ambulatory area to handle two types of patients.

clinic or no emergency services), like the spokes of a wheel (multiple services), or even as a straight line, double-corridor system including all four radiologic PPC areas and radiotherapy (Fig. 4).

The concept of progressive patient care applied to radiotherapy would probably be best served by a double-ended area with supervised in-patient waiting area on one end and ambulatory patient waiting on the other. The concept of a double-ended area need not be limited to a straight line. For example, the radiotherapy unit could be "U"-shaped, thus bringing the two waiting areas side by side. Many other configurations may be feasible in particular situations. Economic factors would usually dictate the use of the same therapy units for patients of both types. All rooms, corridors, and doors, therefore, must be of sufficient size to allow easy movement of stretchers and beds. Similar arrangements should be

made for diagnostic and therapeutic isotope areas.

In planning hospital radiologic facilities, there are two important statistical figures which have become accepted as standard guides (5-7). These are 100 sq. ft. per patient examined or treated per day, and one x-ray machine per 17 patients examined or treated per day (17 patients/day yield approximately 20 examinations/day). These figures are based on *average* patient loads. If patient loads fluctuate greatly, or if special examinations are a large part of the load, some revision of the *average* figure must be made if patients are to receive optimal care.

In a well planned general hospital department of radiology, the figure of 100 sq. ft./examination/day is probably adequate. In a university structure with a

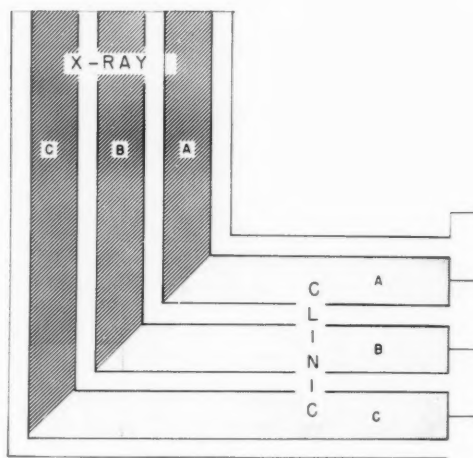


Fig. 3. The "Interleaving Plan," a method whereby specific x-ray facilities are made available to the specific clinics utilizing those facilities. For example "A" might be Dentistry, "B" Orthopedics, "C" Gastroenterology and Cardiology, etc.

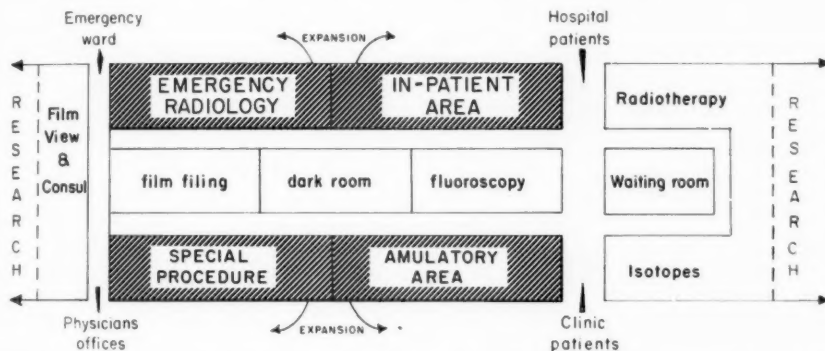


Fig. 4. The straight line, double corridor PPC system. Note that the four radiologic PPC areas may be interchanged about the central darkroom, fluoroscopy, and film files. Physician traffic would be mostly to the left; patient traffic to the right. Radiotherapy may be added to the right with the combined efficiency of a single waiting area. Expansion area is provided to the north and south.

large teaching load, this figure may need upward revision. In the small hospital with less teaching, few emergencies, and no special examinations, the figure could be revised downward.

An Ambulatory Patient Area can usually be planned on the basis of 20 patients examined per day. To allow for the extra difficulty in examining sick patients, *In-Patient Areas* should be planned on the basis of 15 patients examined/day. Because of the unpredictability of emergency situations and the need for expeditious

examination of patients, radiology *Emergency Areas* should be planned for an *average* of no more than 10 patients examined/day. *Special Procedures*, such as neuroradiology and angiocardiology, can hardly be performed adequately and accurately at an *average* rate of more than 5 patients examined/day.

The concept of "progressive patient care" in hospitals will continue to expand. By extending and applying this concept to the radiologic care of patients, the radiologist can help provide the most

expeditious care of the patient and more ideal consultation between physicians, while at the same time reducing the patient-costs in terms of time, money, and radiation exposure.

The J. Hillis Miller Health Center  
University of Florida, Gainesville, Fla.

#### REFERENCES

1. GOLIN, M.: At Last: a Hospital to Fit Doctor-Patient Needs. *J.A.M.A.* **166**: 2180-2183, April 26, 1958.
2. Coming: Better Hospital Care at Lower Cost. New System of "Progressive Patient Care" Concentrates Service Where Needed. *Changing Times*, The Kiplinger Magazine, August 1958, pp. 31-32.
3. The Challenge to America: Its Economic and Social Aspects. Report of Panel IV of the Special Studies Project, Rockefeller Brothers Fund, Inc. 1958, Garden City, New York, Doubleday & Company, Inc., 1958.
4. Hospital of the Future. *Science News Letter*, July 5, 1958, pp. 10-11.
5. AMERICAN COLLEGE OF RADIOLOGY: Planning Guide for Radiologic Installations. By the Committee on Planning of Radiologic Installations of the Commission on Public Relations, W. G. Scott, Chairman, Chicago, The Year Book Publishers, Inc., 1953.
6. DONALDSON, S. W.: The Practice of Radiology in the United States: Facts and Figures. *Am. J. Roentgenol.* **66**: 929-946, December 1951.
7. DONALDSON, S. W., AND LAVIELLE, C. J.: A Supplementary Report to "The Practice of Radiology in the United States: Facts and Figures." Special Report to the American College of Radiology, 1958.

#### SUMMARIO IN INTERLINGUA

##### Progressive Assistentia pro Patientes in le Radiologia

Un programma de "progressive assistentia pro le patiente" provide tres areas intra le organisation del hospital ubi le assistentia medical es adaptate al requirimentos del patiente super le base del constataciones del medico individual. Iste areas es: Un area de assistentia intense pro seriemente malade patientes e pro patientes qui require un immediate assistentia post-operatori, un area de assistentia intermediari pro patientes qui require le attention usualmente offerite per infirmeras in nostre dies, e un area de auto-adjuta pro patientes qui pote satisfacer multes de lor necessitates per lor proprie ressources. Per extender iste conception e applicar lo al assistentia radiologic, un expeditive

manipulation del patientes e un typo ideal de consultation inter le medicos pote esser effectuate, durante que simultanee-mente le costos per patiente in tempore, moneta, e exposition radiatori pote esser reducite.

Quatro areas principal debe esser considerate in le diagnose radiologic del patientes: Situationes de urgentia, procedimentos special, patientes residente, e patientes visitante. Iste areas pote esser disponite in le figuration de un H, un X, un Y, o un T; como le radios de un rota o mesmo in un linea recte con un systema a corridor duple. In omne plano, attention debe esser prestate que le expansion del facilitates remane possibile in plure directiones.



## WORK IN PROGRESS

### Studies in Coronary Arteriography

#### Systolic vs. Diastolic Appearance of the Coronary Arteries<sup>1</sup>

OTTHEINRICH HASE, M.D.,  
DUNCAN A. HOLADAY, M.D., and  
RALPH A. DETERLING, JR., M.D., Ph.D.

In a previous communication (1) we have described a technic for coronary arteriography in which both the injection of contrast material and the radiographic exposure are timed relative to the cardiac cycle.<sup>2</sup> For this, the electrocardiogram and aortic pressure curves are simultaneously recorded and considered in the interpretation of the radiographs. The exposure signal on the oscillographic record is

produced by means of a photocell which is activated by the x-ray beam passing through a fluorescent screen.

One observation which we have made repeatedly is that the anterior descending branches of the left coronary artery appear tortuous when the x-ray exposure is made in systole (Fig. 1,A). This is apparently due to the shortening of the contracting ventricles which forces the surface branches into a number of noticeable bends. In contrast, the left circumflex coronary artery, which circles the annulus fibrosus in the atrioventricular groove in a plane approximately 90° to the long axis of the ventricular chambers, is not subjected to such shortening in its course. It therefore appears unchanged in this projection (Fig.1).

Another potential application of this technic is for the measurement of arterial blood vessel distensibility. As may be noted in Figure 1, the diameter

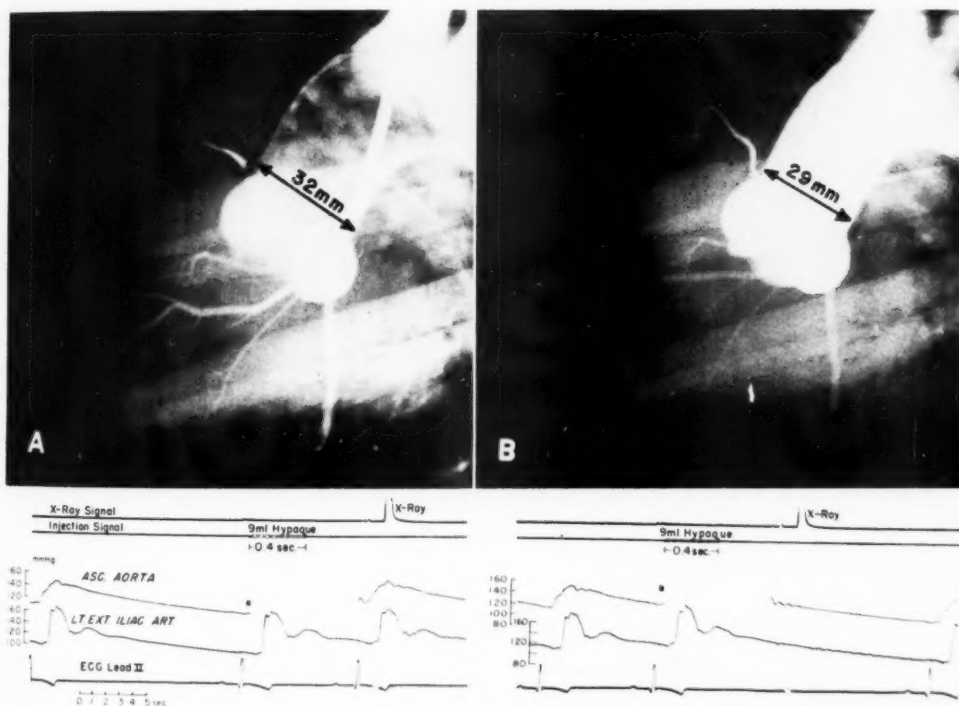


Fig. 1. Dog 584C, 27 kg., morphine-chloralose anesthesia. Transcarotid catheter N.I.H. type, size 9F. Nine milliliters 50 per cent Hypaque was injected within 0.4 seconds during systole and during protodiastole. Exposure: 400 ma; 76 kvp; 1/20 second; 36 inches T.F.D.

A. Exposure in systole: anterior descending branches tortuous. Aortic diameter: 32 mm.

B. Exposure in diastole: anterior descending branches straight. Aortic diameter: 29 mm.

\*The aortic pressure was recorded through the injection catheter; therefore, the tracing is interrupted during and shortly after the injection.



of the aortic lumen is 3 mm. wider in systole (A) than in diastole (B).

Before one may interpret tortuosity in the course of an anterior descending coronary branch, the precise timing of the exposure relative to the cardiac cycle should be known. Moreover, it would be desirable to have radiographs made in systole and diastole available for any functional evaluation.

#### REFERENCES

1. HASE, O., AND DETERLING, R. A., JR.: Evaluation of Contrast Media Employed for Aortic and Coro-

nary Visualization. *Surg. Forum* 8: 320-324, 1957.

2. DOTTER, C. T., AND FRISCHE, L. H.: Visualization of the Coronary Circulation by Occlusion Aortography: A Practical Method. *Radiology* 71: 502-523, October 1958.

<sup>1</sup> From the Department of Surgery, and the Department of Anesthesiology, College of Physicians and Surgeons, Columbia University, New York, N. Y.

<sup>2</sup> The assistance of Miss Marilyn W. Haasnoot is gratefully acknowledged. In the latter part of our experiments, we have used an improved electrical circuit of Dr. Paul H. Gerst, for the conversion of the QRS complex of the electrocardiogram into the trigger impulse for the injection apparatus.



E

The  
Ninth  
in M  
riched  
sented  
radio  
deligh  
city  
exper  
bers  
increa  
11,000  
the C  
seven  
deleg  
The  
tific F  
plann  
Dr. B  
Prof.  
other  
gratifi  
point  
televi  
tivities  
The  
carrie  
buildi  
the c  
lectur  
were  
The  
the B  
by th  
Prof.  
ident  
gress,  
the f  
follow  
by th  
Mayo  
thuse  
gress.

# EDITORIAL

## The Ninth International Congress of Radiology

The memories of those who attended the Ninth International Congress of Radiology in Munich, July 23-30, will long be enriched by the varied scientific program presented, the personal conferences with radiologists from other countries, and the delightful social occasions. The picturesque city of Munich was in itself a delightful experience. There were some 5,200 members registered, and guests and exhibitors increased the attendance to more than 11,000, making this the largest of any of the Congresses up to present time. Forty-seven nations were represented by official delegates.

The smoothness with which the Scientific Program ran is a tribute to the detailed planning on the part of the President, Prof. Dr. Boris Rajewsky, the General Secretary, Prof. Dr. H. V. Braunbehrens, and the other officers and committees. It was gratifying to have papers read at the appointed times on the program and, through television, to be able to appraise the activities in all meeting rooms at any time.

The activities of the Congress were carried out in a series of closely related buildings in Ausstellungspark not far from the center of the city. Here, in twelve lecture halls, approximately 900 papers were presented.

The Congress was officially opened in the Bavaria Hall, by a speech of welcome by the incoming President, Dr. Rajewsky. Prof. Flemming Møller of Denmark, President of the Seventh International Congress, then invested Dr. Rajewsky with the formal badge of presidential office, following which addresses were delivered by the Bavarian Prime Minister, the Mayor of Munich, and Professor Holthausen, Honorary President of the Congress. Several memorial gavels were also

presented. The ceremonial speech was given by Prof. Dr. Max Von Laue, whose subject was "Examination of X, Neutron, and Electron Rays by Means of Crystals." Several selections by a symphony orchestra were much enjoyed. An interesting feature of the meeting was a "Hall of Honour" in which photographs of outstanding pioneers of radiological research were shown. Many countries were represented and it was a stimulating experience to see the photographs of these pioneers. The Americans thus honored were Dr. Eugene W. Caldwell, Dr. Russell D. Carman, Dr. Arthur C. Christie, and Dr. George E. Pfahler.

The scientific sessions consisted of General Meetings and Sections on (I) Diagnostics, (II) Therapy, (III) Nuclear Medicine and Therapy with High Energy Radiation, (IV, A) Radiobiology and Biophysics, (IV, B) Danger Posed by Rays and X-ray Protection, (V) Physics and Technic, (VI) Legal Aspects and Laws, Economy, Training, and Research in Radiology.

It is obviously impossible to assess properly the great wealth of material which was presented by workers from all over the world. Some meetings dealt with special aspects of radiology. These cannot be covered in detail but the main themes included: Image Amplification and Television in X-ray Diagnostics; Elementary Mechanism of the Effect of Radiation; Osteoporosis; Angiography; Radiological Standards; Automation and Automatism in Diagnostics; Radiotherapy of Malignant Tumors of the Mouth and Nasopharynx; Preoperative Irradiation of Malignant Tumors; Measurements of Flow and Circulation; Radiological Protection Dosimetry; Technic in Diagnosis; Bron-

chial Carcinoma; Biological Effect of Radiation; Radiation Exposure and Protective Measures; Burden of Irradiation on the Population through Medical Irradiation; Supervoltage Therapy; Radioactive Research; Effect of X-rays on Cellular Metabolism; Lymphography; Maximum Permissible Dosage; Neuroradiological Examinations; Somatic After-Effects of X-ray Treatments; Endocrine Systems; Pharmacoradiography; X-ray Genetics; Present Tasks and Responsibilities of Radiology.

The papers were delivered in the four official languages of the Congress. In two of the halls simultaneous translations into the various languages were available by the use of head phones. The translations, into English at least, were unfortunately somewhat below the usual standard.

The scientific exhibits were adequately housed and nicely presented. They covered a wide variety of subjects devoted to diagnostic and therapeutic subjects. A considerable amount of space was given over to nuclear medicine.

The technical exhibit was unusually large, with a floor space of about 60,000 square feet. It was marked by the demonstration of equipment made in many countries and covering every radiological field. Prominently featured were equipment for rotation therapy by means of radioactive materials; automatic processing of films; image amplification combined with cineradiography; laminagraphy; nuclear medicine; and refinements of standard apparatus for diagnosis and therapy.

It was announced that the Tenth International Congress will be held in Montreal, Canada, the last week in August 1962, with Dr. Arthur C. Singleton, Toronto, as

President, and Dr. Carleton B. Peirce of Montreal as Secretary-General.

An interesting side light of the meeting was the dedication, on July 20, of a new wing of the German Roentgen Museum in Remscheid-Lennep, Roentgen's birthplace. The International Executive Committee held their first official meeting in the house where Roentgen was born. Various officials of the city and of the Congress participated, the main address being given by Mr. Lauriston S. Taylor. A reception by the German Roentgen Society followed the ceremonies.

The Council and the Assembly of the International Society of Radiology met on Wednesday July 22d. The purpose of this Society, organized at the Seventh Congress in Copenhagen in 1953, is to support financially the work of the International Commissions. It is composed of national radiological organizations in the various countries, known as "Member Societies." The American College of Radiology is the "Member Society" in the United States.

The social program of the Congress was of unusual interest. A number of the evening programs involved visits to nearby castles and museums, with appropriate entertainment. A banquet with dancing at the Mathaser was the outstanding formal evening occasion. Many receptions were held during the week. A "Munich Evening," also at the Mathaser, included many types of Bavarian entertainment, food, and drinks. Excursions, fashion shows, etc., were provided daily for the ladies.

Reports of the Commissions on Radiological Units and Measurements, Radiological Protection, and Stage Grouping and Presentation of Results will appear in a later issue of RADIOLOGY.

AM  
At  
Roent  
Ohio,  
assum  
were  
M.D.,  
Coe,  
Presid  
Wash.  
Clinic  
Arbuc  
The  
by Dr  
The  
Amba  
CL  
New  
logical  
Presid  
Norm  
Shake  
John  
The  
of Oct  
and A  
CO  
New  
Societ  
Color  
M.D.  
M.D.  
3705  
The  
on the  
MIL  
At  
Ray  
Presid  
Gene  
Josep  
The  
throu  
M  
The  
electe  
M.D.  
M.D.  
M.D.

## ANNOUNCEMENTS AND BOOK REVIEWS

### AMERICAN ROENTGEN RAY SOCIETY

At the Sixtieth Annual Meeting of the American Roentgen Ray Society, Sept. 22-25, in Cincinnati, Ohio, Dr. Edward B. D. Neuhauser, Boston, Mass., assumed the Presidency and the following officers were elected: President-Elect, Harold G. Reineke, M.D., Cincinnati; First Vice-President, Fred O. Coe, M.D., Washington, D. C.; Second Vice-President, Frederic E. Templeton, M.D., Seattle, Wash.; Secretary, C. Allen Good, M.D., Mayo Clinic, Rochester, Minn.; Treasurer, Robert K. Arbuckle, M.D., Oakland, Calif.

The Annual Caldwell Lecture was delivered by Dr. Donald L. McRae, of Montreal.

The 1960 Annual Meeting will be held at the Ambassador Hotel, Atlantic City, Sept. 27-30.

### CLEVELAND RADIOLOGICAL SOCIETY

Newly elected officers of the Cleveland Radiological Society are: Emmett O'Malley, M.D., President; Robert L. Garber, M.D., Vice-President; Norman E. Berman, M.D., 14404 S. Park Blvd., Shaker Heights 20, Ohio, Secretary-Treasurer; John L. Gaughan, M.D., Member-at-Large.

The Society meets at 7.00 P.M. the fourth Monday of October, November, January, February, March, and April at the Tudor Arms Hotel.

### COLORADO RADIOLOGICAL SOCIETY

Newly elected officers of the Colorado Radiological Society are as follows: Vernon L. Bolton, M.D., Colorado Springs, President; Paul E. RePass, M.D., Denver, Vice-President; Charles F. Gaylord, M.D., Denver, Treasurer; Bertram L. Pear, M.D., 3705 E. Colfax Ave., Denver 6, Secretary.

The Society meets at the Denver Athletic Club on the third Friday of each month.

### MILWAUKEE ROENTGEN RAY SOCIETY

At a recent meeting of the Milwaukee Roentgen Ray Society, the following officers were elected: President, Robert W. Byrne, M.D.; Vice-President, Gene W. Sengpiel, M.D.; Secretary-Treasurer, Joseph F. Wepfer, M.D., 5000 W. Chambers St.

The Society meets on the fourth Monday, October through May, at the University Club.

### MONTANA RADIOLOGICAL SOCIETY

The Montana Radiological Society recently elected the following to office: L. H. Blattspieler, M.D., Helena, President; Harold F. Hagan, M.D., Anaconda, Vice-President; J. K. Boughn, M.D., 35—11th Ave., Helena, Secretary-Treasurer.

### MONTREAL RADIOLOGICAL STUDY CLUB

At the first meeting of the Montreal Radiological Study Club for 1959-60, the following officers were elected: President, D. W. MacEwan, M.D.; Vice-President, H. P. Levesque, M.D.; Secretary-Treasurer, Fleming McConnell, M.D., 1650 Cedar Ave., Montreal, Que.

### NORTH CAROLINA RADIOLOGICAL SOCIETY

Newly elected officers of the North Carolina Radiological Society are as follows: President-Elect, Isadore Meschan, M.D., Winston-Salem; Vice-President, James Marr, M.D., Winston-Salem; Secretary-Treasurer, Owen Doyle, M.D., 1015 Professional Village, Greensboro; Executive Committee Member, Charles A. Bream, M.D., Chapel Hill (1959-61).

### ROCKY MOUNTAIN RADIOLOGICAL SOCIETY

At the recent Annual Meeting of the Rocky Mountain Radiological Society, the following officers were elected: President-Elect, Peter E. Russo, M.D., Oklahoma City, Okla.; First Vice-President, John W. Walker, M.D., Kansas City, Mo.; Second Vice-President, Maurice C. Archer, M.D., Fort Worth, Texas; Secretary-Treasurer, John H. Freed, M.D., 4200 E. Ninth Ave., Denver 20, Colo.; Executive Committee, Mark S. Donovan, M.D., Denver, Colo.; Program Committee, Ralph C. Moore, M.D., Omaha, Nebr.

The 1960 meeting will be held in Denver, Colo., Aug. 11-13, at the Denver Hilton Hotel.

### WISCONSIN RADIOLOGICAL SOCIETY

New officers of the Wisconsin Radiological Society include: Robert W. Byrne, M.D., Milwaukee, President; Farrell F. Golden, M.D., Madison, President-Elect; Howard G. Bayley, M.D., Beaver Dam, Secretary-Treasurer. The Councilor to the American College of Radiology is Irving I. Cowan, M.D., Milwaukee, and the Alternate Councilor, Ralph C. Frank, M.D., Eau Claire.

### KIRKLIN-WEBER MEMORIAL LECTURE

The first Kirklin-Weber Memorial Lecture was given in Rochester, Minn., Nov. 20 by Dr. Leo G. Rigler, former Professor of Radiology of the University of Minnesota, now Executive Director of Cedars of Lebanon Hospital of Los Angeles. Dr. Rigler spoke on "The History of Roentgenology of the Gastro-Intestinal Tract."

The Kirklin-Weber Memorial Fund, which supports this lectureship, was contributed by former students and friends of the late Dr. B. R. Kirklin and Dr. H. M. Weber.

#### NEW GAMMA-RAY RADIOACTIVITY STANDARDS

The National Bureau of Standards announces the availability of three new gamma-ray radioactivity standards. Strontium-85, niobium-95, and mercury-203 can now be obtained in approximately 5 grams of solution, sealed in glass ampules.

For the most part, nuclides issued as radioactivity standard samples are used as calibrated working standards for the same nuclide. Strontium-85 is an exception to this rule. This particular nuclide emits gamma rays with an energy of 513 kev, which is almost identical to the energy of positron annihilation radiation. Strontium-85 can therefore be used to calibrate instruments for positron emitter measurements. Strontium-85 has a half-life of sixty-five days.

Niobium-95 emits one beta particle ( $E_{\max} = 160$  kev) and one gamma ray ( $E = 768$  kev). Its half-life is thirty-five days. Mercury-203 also emits one beta particle ( $E_{\max} = 208$  kev) and one gamma ray ( $E = 279$  kev). In addition, x-radiation is present. Mercury-203 has a half-life of 46.5 days.

As of Aug. 15, 1959, the strontium-85 sample had a total nominal activity of  $2 \times 10^6$  disintegrations per second, niobium-95 had  $6 \times 10^6$  disintegrations per second, and mercury-203 had  $10^7$  disintegrations per second. As these standards, because of their high activities, can be issued only under the special licensing provisions of the Atomic Energy Act of 1954, it is required that a copy of the purchaser's current AEC by-products material license be on file at the bureau. The new standard samples may be obtained from the Radioactivity Section, National Bureau of Standards, Washington 25, D. C., for \$27.00 each.

#### JAMES PICKER FOUNDATION FELLOWSHIPS

On behalf of the James Picker Foundation, the National Academy of Sciences-National Research Council announces a new fellowship program, designed in the interests of academic radiology.

*James Picker Foundation Advanced Fellowships in Academic Radiology* are now offered in addition to the previously established research fellowships and research grants, which will be continued during 1960-61. These new awards are planned to prepare the candidate to meet in full the intellectual demands of an academic position in radiology. Emphasis is placed upon the acquisition of a broad background in the basic sciences related to radiology. In gen-

eral, it is expected that the candidate will be not more than thirty-three years of age and will have completed his clinical training. He should be prepared to devote a minimum of two years to course work in the basic sciences, to the application of the techniques and methods of these basic disciplines to radiological research, and to other activities designed to enhance his preparation for an academic career. Applications will be accepted on nomination by a clinical adviser, who should be a member of the staff of a department of radiology in a medical school.

*Postdoctoral Fellowships in Radiological Research, Grants for Scholars, and Grants-in-Aid of Research* continue to be offered as in former years (see *Radiology* 71:759, 1958).

Applications in the four categories will be reviewed by the Committee on Radiology of the Academy-Research Council's Division of Medical Sciences. Final determination of awards is made by the Foundation upon recommendation of the Division. Support is not restricted to citizens of the United States or to laboratories within this country.

Applications for the fiscal year 1960-61 should be submitted by Dec. 15, 1959. Further details and application blanks may be obtained from the *Division of Medical Sciences—Room 411, National Academy of Sciences-National Research Council, 2101 Constitution Ave., N. W., Washington 25, D. C.*

If the proposed studies are to be carried out in Canada, requests for information and application forms should be directed to the Awards Office, National Research Council of Canada, Ottawa 2, Canada.

## Letters to the Editor

### To the Editor of Radiology

DEAR DR. DOUB:

I was interested to see the report of further cases of pulmonary alveolar microlithiasis by Dr. Gonzalo Esguerra Gómez and his colleagues in the April 1959 issue of *RADIOLOGY*. It is likely that this rare condition will be increasingly reported as it is more widely recognized, because the x-ray appearances, once seen, are unmistakable, especially when taken in conjunction with the clinical history, and often supported by a familial occurrence.

I do not believe that pleural thickening is a characteristic feature of this condition as suggested in the above paper, although, of course, it can result from the physiological breakdown that eventually overtakes the lungs and heart, or from any chance concurrent infection. The white lines of the interlobar fissures and overall lung surfaces are subpleural and due to concentration of the calcospherites. This was well seen in many of the cases reported by the late Dr. Sosman and his colleagues (*Am. J. Roentgenol.* 77:947, 1957), and in my own reported



case (J. Fac. Radiologists 10: 54, 1959); it is well demonstrated in Gough's paper-mounted section reproduced by Sosman, and must be considered a characteristic feature of the disease. At the interlobar surfaces the line will be seen more clearly because two adjacent lung surfaces and their subpleural concentration of calculi are contributing to the shadow.

Yours sincerely,  
W. R. COLE, M.B., D.M.R.D.  
Fremantle, Perth  
Western Australia

Dr. Esquerro Gómez has replied to the above letter of Dr. Cole, as follows:

*To the Editor of Radiology*

DEAR DR. DOUB:

I am entirely in agreement with Dr. W. R. Cole that the radiological aspect of thickening of the lesser interlobar fissure cannot be considered a pathognomonic sign of pulmonary alveolar microlithiasis. For this reason alone we have pointed out the fact that, in our three cases in which the lesions had not completely obscured the lower half of the pulmonary fields, there was appreciably a radiologic aspect of thickening of the fissures.

Evidently, in our Case I (Case No. 3 of Dr. Sosman), and in other published observations as described by Dr. Sosman, "the minor interlobar fissure was definitely thickened and dense, probably due to heavy deposits of calcium salts." But in our other 2 cases, and in some of the published examples, the shadow is exclusively that of fissural thickening and one is unable to declare that there is "subpleural concentration of calculi." In the paper-mounted section of Gough, to which Dr. Cole refers, one does not see fissural thickening but accentuation of deposits (microliths) along the interlobar fissure. A corresponding roentgenogram made on the living patient is not reproduced.

Unfortunately, aside from the Gough's thin paper-mounted section of lung, there are no other anatomical or histologic studies which permit one, in the individual case, to be sure of the explanation of the radiological appearance. But since we are always concerned with an anomaly localized over the lesser interlobar fissure, since the roentgen aspect makes one think of fissural thickening, and since, not only in our own cases but in various of the other published cases the same roentgen aspect appears, it seems appropriate to call attention to it and to hold it in mind in future anatomopathological studies.

Yours sincerely,  
GONZALO ESGUERRA GÓMEZ, M.D.  
Clínica de Marly  
Bogotá, Colombia, S. A.

*To the Editor of Radiology*

DEAR DR. DOUB:

In my paper, "Genetic Effects in Children and Grandchildren of Women Treated for Infertility and Sterility by Roentgen Therapy," in the April 1959 issue of RADIOLOGY, there appeared statistical data which evoked the remarks of Dr. R. R. Newell, in the August issue of the Journal (Vol. 73, p. 275).

Dr. Newell first cites Dr. Friedell as calling attention to the fact that in my series there were 12 post-natal deaths, all in males. The figure given by Dr. Friedell in his original discussion was 11. Actually I reported 20 post-natal deaths (Table I), and nowhere did I state that these were all in males.

Of particular significance is the fact that of the total 566 first-generation children, 282 were males and 284 females (p. 519). This is almost better than normal. If the sex ratio were disturbed, there would have been some imbalance in these figures.

I stated: "There are 543 normal, healthy living children: 260 boys and 283 girls... Twenty children died at or after birth and 3 are alive with abnormalities." Actually the figure for normal, healthy, living boys is 268 (a drop of 14: 12 dead and 2 with abnormalities) and for normal, healthy girls 275 (a drop of 9: 8 dead and 1 with abnormalities). This sex ratio of deaths, 12 boys to 8 girls, is not statistically different from normal.

Dr. Newell calculated the death rate to be 2.1 per cent, which is less than the normal of 3.5 per cent, further gratifying evidence of normality.

In the face of this evidence on human beings, it is understandable why those who are allegedly "concerned about radiation hygiene" must revert to extrapolations from that type of animal data only which supports their point of view.

In my series there has been no excess of deaths and one may properly state that there has been no increase in genetic abnormalities that may be ascribed to irradiation.

Sincerely yours,  
IRA I. KAPLAN, M.D.  
New York, N. Y.

*To the Editor of Radiology*

DEAR DR. DOUB:

It appears that exposure of parts of our bodies to small amounts of radiation may not be as bad as some have feared who have read published predictions of ten days life-shortening from 1 r of total-body exposure. Nevertheless, we shall be wise to continue to avoid unnecessary exposure and to cultivate a reputation for being notably careful. It won't do to pooh-pooh small hazards, especially ones that are difficult to measure.

It is being recommended that films show cone cut-off on at least three corners. Adjustable collimators come rectangular as well as iris, however.

Perhaps quibblers will undertake to shoot at our slogan: "*the three-cornered film.*" If so we could abandon that in favor of "*the silver-tipped film.*"

Yours very truly,  
R. R. NEWELL, M.D.  
San Francisco, Calif.

## In Memoriam

J. WILLIAM JONES, M.D.

1903-1959

Doctor J. William Jones, of Pottsville, Penna., died on Sept. 24, 1959, after a rather prolonged illness. He had been radiologist at the Pottsville Hospital since 1932.

Dr. Jones was a native of Georgia and received his medical training at Emory University. After substantial training in neurosurgery, orthopedic surgery, and pathology, he settled on radiology for his life work. In the relatively small community of Pottsville, Bill Jones soon became an outstanding general practitioner's radiologist. He brought to his community substantial knowledge in radiology and the desire and ability to translate this into practical consultative medicine. An expert amateur photographer, he was able to utilize this talent to a substantial degree in his radiologic practice.

Bill Jones was, above all, a citizen, occupying an important place in his community. He was active particularly in the American Cancer Society, both in Schuylkill County and at the state level; for a number of years he was on the Cancer Commission of the Medical Society of the State of Pennsylvania. Active in the Pennsylvania Radiological Society, he was for many years its best golfer and promoter of the annual golf tournament. He will be missed by his many friends.

## Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

**THE MEDIASTINUM.** By TED F. LEIGH, M.D., Professor of Radiology, Emory University School of Medicine, Director of the Department of Radiology, Emory University Hospital, Member of the Section of Radiology, Emory University Clinic, Atlanta, Ga., AND H. STEPHEN WEENS, M.D., Professor of Radiology and Chairman of the Department of Radiology, Emory University School of Medicine, Director of the Department of Radiology, Grady Memorial Hospital, Chief of the Section of Radiology, Emory University Clinic, Atlanta, Ga. A volume of 246 pages, with 290 figures. Published by Charles C Thomas, Springfield, Ill., 1959. Price \$11.50.

**DISORDERS OF THE TEMPOROMANDIBULAR JOINT. DIAGNOSIS, MANAGEMENT, RELATION TO OCCLUSION OF TEETH.** By LASZLO SCHWARTZ, D.D.S., Clinical Professor of Dentistry, Columbia University; Director, Temporomandibular Joint Clinic, Columbia-Presbyterian Medical Center, and 18 contributors. Introduction by Charles Ragan, M.D., Professor of Clinical Medicine, Columbia University. Foreword by Harry Sicher, M.D., D.Sc., Professor of Anatomy, Loyola University School of Dentistry, Chicago. Illustrated by Robert J. Demarest. A volume of 472 pages, with 458 illustrations on 168 figures. Published by W. B. Saunders Co., Philadelphia, Penna., 1959. Price \$15.00.

**DIAGNOSTIC RADIOISOTOPES.** By CHARLES A. OWEN, JR., M.D., Ph.D. (Med.), Section of Clinical Pathology, Mayo Clinic, and Associate Professor of Clinical Pathology, Mayo Foundation Graduate School, University of Minnesota, Rochester, Minn. A volume of 426 pages, with 71 figures, 49 tables, and 1 nomogram. Published by Charles C Thomas, Springfield, Ill., 1959. Price \$15.75.

**A TEXT-BOOK OF X-RAY DIAGNOSIS BY BRITISH AUTHORS. In Four Volumes. VOLUME IV: THE BONES, JOINTS, AND SOFT TISSUES.** Edited by S. COCHRANE SHANKS, C.B.E., M.D., F.R.C.P., F.F.R., Director, X-Ray Diagnostic Department, University College Hospital, London, AND PETER KERLEY, C.V.O., C.B.E., F.R.C.P., F.F.R., D.M.R.E., Director, X-Ray Department, Westminster Hospital; Radiologist, National Heart Hospital, London. A volume of 714 pages, with 735 illustrations. Published by W. B. Saunders Co., Philadelphia, Penna., 3d ed., 1959. Price \$21.00.

**ROENTGENS, RADS, AND RIDDLES. A SYMPOSIUM ON SUPERVOLTAGE RADIATION THERAPY HELD AT THE MEDICAL DIVISION, OAK RIDGE INSTITUTE OF NUCLEAR STUDIES, JULY 15, 16, 17, AND 18, 1956.** Edited by MILTON FRIEDMAN, M.D., MARSHALL BRUCER, M.D., AND ELIZABETH ANDERSON, Oak Ridge Institute of Nuclear Studies, Oak Ridge, Tennessee, U. S. Atomic Energy Division. A volume of 496 pages, with figures and tables. For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., 1959. Price \$3.50.

**QUANTITIES, UNITS AND MEASURING METHODS OF IONIZING RADIATION. A SYMPOSIUM (ROME, APRIL 14-15, 1958).** Edited by PROF. FRANCO FOSSATI, assisted by DR. LIA FORTI. Società italiana di radiologia medica e di medicina nucleare and Istituto superiore di sanità. A volume of 360 pages, with figures and tables. Published by Ulrico Hoepli, Milan, Italy, 1959. (In English.)

**RADIOACTIVE FALLOUT—A TWO-YEAR SUMMARY REPORT.** By CHARLES L. DUNHAM, M.D., Director, Division of Biology and Medicine, U.S. Atomic Energy Commission. Prepared for presentation at the Hearings on Fallout before the Joint Committee on Atomic Energy, May 5-8, 1959. TID 5550. A monograph of 110 pages. Available from the Office of Technical Services, Department of Commerce, Washington 25, D. C., 1959. Price \$1.25.

**TUMORS OF THE PANCREAS.** By VIRGINIA KNEELAND FRANTZ, M.D., Professor of Surgery, College of Physicians and Surgeons, Columbia University, Attending Surgical Pathologist, Presbyterian Hospital, New York, N. Y. Atlas of Tumor Pathology, Section VII—Fascicles 27 and 28. A volume of 152 pages, with 1 color plate, 94 figures, and 3 tables. Published by the Armed Forces Institute of Pathology under the auspices of the Subcommittee on Oncology of the Committee on Pathology of the Division of Medical Sciences of the National Academy of Sciences—National Research Council, Washington, D. C., 1959. For sale by the American Registry of Pathology, Armed Forces Institute of Pathology, Washington 25, D. C. Price \$1.50.

**THE LAW OF MEDICAL PRACTICE.** By BURKE SHARTEL, Professor of Law, University of Michigan, AND MARCUS L. PLANT, Professor of Law, University of Michigan. A volume of 446 pages. Published by Charles C Thomas, Springfield, Ill., 1959. Price \$12.50.

**KLINISCHE RADIOLOGIE DES MAGENS UND DES ZWÖLFFINGERDARMS.** By DR. PIERRE PORCHER, Paris, Membre de l'Académie nationale de médecine, Membre de l'Académie de chirurgie, Radiologiste de l'Hôpital Saint-Antoine et de l'Hôpital Américain; DR. HANS-ULRICH STÖSSEL, Bern, Ancien assistant étranger de l'Hôpital Saint-Antoine, Medizinische Poliklinik der Universität Zürich (Prof. Dr. R. Hegglin); AND DR. PAUL MAINGUET, Brüssel, Médecin résident étranger des Hôpitaux de Paris. With a foreword by Prof. Dr. med. H. H. Berg, Hamburg. A volume of 264 pages, with 468 illustrations on 260 figures. Published by Georg Thieme, Herdweg 63, (14a) Stuttgart, Germany, 1959. Distributed in the U. S. A. and Canada by the Intercontinental Medical Book Corporation, New York 16, N. Y. Price DM 72.—(\$17.15).

**STRAHLENBELASTUNG UND STRAHLENSCHUTZ IN DER PÄDIATRISCHEN RÖNTGENDIAGNOSTIK.** By PRIV.-DOZ. DR. KURT HARTUNG, Mainz. A monograph of 128 pages, with 26 figures and 97 tables. Published by Georg Thieme, Herdweg 63, (14a) Stuttgart, Germany, 1959. Distributed in the

U. S. A. and Canada by the Intercontinental Medical Book Corporation, New York 16, N. Y. Price DM 18.60.—(\$4.45).

**STRAHLENBIOLOGIE: GRUNDLAGEN UND ERGEBNISSE.** By PROF. DR. HEDI FRITZ-NIGGLI, Zürich. A volume of 380 pages, with 301 illustrations on 168 figures. Published by Georg Thieme, Herdweg 63, (14a) Stuttgart, Germany, 1959. Distributed in the U. S. A. and Canada by the Intercontinental Medical Book Corporation, New York 16, N. Y. Price DM 65.—(\$15.50).

## Book Reviews

**BRONCHOGRAPHY.** By C. DIJKSTRA, M.D., Medical Superintendent of "De Klokkenberg," sanatorium and chest hospital, Breda, the Netherlands. A monograph of 158 pages, with 106 figures. Published by Charles C Thomas, Springfield, Ill., 1958. Price \$9.50.

This short monograph, which comes from The Netherlands, opens with a chapter covering the technic and hazards of bronchography, and presenting a classification of the general forms of bronchial disease. Succeeding chapters take up Intrapulmonary Foreign Bodies; Malignant Pulmonary Lesions; Chronic Granulomatous, Inflammatory Lesions of the Lung (Tuberculosis, Silicosis, Sarcoid of Boeck); Acute and Subchronic Abscess-Forming and Non-Abscess-Forming Pneumonic Disease; Chronic Bronchitis, Emphysema, and/or Bronchial Asthma; Bronchiectasis.

Except for a minimum of comment on the conditions considered, the text is made up wholly of case reports, well illustrated with plain roentgenograms, bronchograms, and photographs of gross specimens.

Those interested in bronchographic diagnosis will find this a concise, readable text.

**CLINIQUES RADIOLOGIQUES. PREMIÈRE SÉRIE: L'AGRANDISSEMENT RADIOGRAPHIQUE DIRECT DANS L'EXAMEN DE LA BASE DU CRÂNE ET DES MICRO-FRACTURES DU ROCHER.** By PROF. J. ROUSSEL, Chaire d'électroradiologie clinique de la Faculté de Médecine de Nancy. With the collaboration of P. SCHOUMACHER, M. PERNOT, AND R. POIRÉ. Preface by Prof. P. Lamarque. A volume of 102 pages, with 59 figures. Published by Masson & Cie, 120, Boulevard Saint-Germain, Paris VI<sup>e</sup>, France, 1959. Price 3,200 fr.

This monograph begins by considering the possibilities and limitations of radiographic enlargement with the use of small focal spots. This technic is then applied to the study of the base of the skull. It is believed to be of special help in diagnosing fractures of the petrous bone. A discussion of several views is given, with line drawings and

roentgenograms. Correlation of the various types of fracture lines which may occur and the corresponding clinical symptoms is usually good.

Throughout the monograph the line drawings are of great value in pointing up the relationships on the roentgenograms. This is definitely helpful in the search for small fracture lines in dense bone.

**ANGIOCARDIOPNEUMOGRAPHIE ÉLARGIE: MÉTHODE D'OPACIFICATION VASCULAIRE GÉNÉRALE PAR VOIE VEINEUSE.** By P. VIALLET, Électroradiologiste des hôpitaux (Alger), L. SENDRA, Chef de Clinique à la Faculté de Médecine d'Alger, L. CHEVROT, Ancien Chef de Clinique à la Faculté de Médecine d'Alger, P. AUFRY, Chef de Clinique à la Faculté de Médecine d'Alger, AND P. COMBE, Professeur agrégé à la Faculté de Médecine d'Alger. A volume of 110 pages, with 46 figures. Published by Masson & Cie, 120, Boulevard Saint-Germain, Paris VI<sup>e</sup>, France, 1959. Price 4,400 fr.

This is an extensive discussion of the possibilities of studying various arterial and venous structures in rather large regions of the body following intra-

venous injection of a concentrated triiodic contrast agent. The authors use 1 ml. per kilogram of body weight, injecting the contrast agent as rapidly as possible with the aid of a mechanical syringe which contains an equal amount of saline above the level of the contrast substance. Since the injection is made intravenously, the risk is believed to be minimized.

Films were obtained of the heart and lungs, the shoulder region, the head and neck, the abdomen and pelvis, and other relatively large areas. Many interesting reproductions show rather good visualization of extensive segments of the arterial system.

The authors recommend the use of this technic in studying lesions of the brain, various cardiac defects, pulmonary diseases, and diseases of the kidneys and abdominal aorta. Although it would seem to the reviewer that other more specific procedures are probably better in specific instances such as cerebral angiography and angiocardiology, there is no doubt that this interesting method may prove of value under certain circumstances. Its application to abdominal aortography might be quite worthwhile.



The He

DYKEN

Di

of

NETTL

Di

gr

Le

THIELE

Pa

MURPH

Av

of

MASSO

th

lo

FULLE

C

tic

GREEN

at

T

PRATT

A

A

A

The C

LÖHR,

it

g

STRAD

I

S

CHAC

P

C

COLE

GALL

S

F

FELSO

g

P

GOLD

I

LE M

C

M

DEMO

M

The I

McF

I

## ABSTRACTS OF CURRENT LITERATURE

### ROENTGEN DIAGNOSIS

#### The Head and Neck

- DYKEN, MARK. Pneumoencephalography with Direct Injection and Positional Directing of Air..... 799
- NETTL, S., ET AL. Our Experiences with the Diagnostic Utilization of the Deep Phlebogram in Intracranial Space-Occupying Lesions..... 799
- THIELE, G. A Rare Calcific Shadow in the Parasellar Space..... 799
- MURPHEY, FRANCIS, AND SHILLITO, JOHN, JR. Avoidance of False Angiographic Localization of the Site of Internal Carotid Occlusion..... 800
- MASSOUD, G. E., AND AWWAD, H. K. Scleroma of the Upper Air-passages: A Clinico-radiological Study of 84 Cases..... 800
- FULLER, A. P., ET AL. Sphincteric Action of Cricopharyngeus: Radiographic Demonstration..... 800
- GREEN, RODNEY I. The Radiological Appearances of the Soft Palate with Reference to the Treatment of Cleft Palate..... 800
- PRATT, T. L. C. Spontaneous Dislocation of the Atlanto-axial Articulation Occurring in Ankylosing Spondylitis and Rheumatoid Arthritis..... 801

#### The Chest

- LÖHR, HH., ET AL. Normal and Pathologic Pulmonary Segments in the Selective Angiogram..... 801
- STRADLING, PETER, AND DIXON, W. M. Possible Disadvantages of a Chest Radiography Service for General Practitioners..... 801
- CHACE, JOHN F., AND COFFAY, E. P., JR. Role of Photofluorography in Navy Tuberculosis Control..... 801
- COLE, W. R. Pulmonary Alveolar Microlithiasis. S. Lung Changes in the Recent Influenza Epidemic..... 802
- GALLOWAY, RAYMOND W., AND MILLER, RONALD FELSON, BENJAMIN. Some Less Familiar Roentgen Manifestations of Intrathoracic Histoplasmosis..... 802
- GOLDFISCHER, JEROME, AND RUBIN, ELI H. Dermatomyositis with Pulmonary Lesions..... 803
- LE MELLETIER, J., ET AL. Bronchopulmonary Complications Revealing an Unrecognized Megaesophagus..... 803
- DEMOULIN, M. Phlebographic Study of the Mediastinum..... 803

#### The Heart and Blood Vessels

- McFALL, RUSSELL A., ET AL. Reaction of the Heart to Selective Angiocardiography..... 803

- YOUNG, BARTON R., ET AL. Ultra-Short (Millisecond) Timing in Roentgen Diagnostic Procedures Including Angiocardiography: Comparison of Dynapulse and Impulse Timing..... 804
- MOSS, ARTHUR J., ET AL. Congenital Malformation of the Cardiac Conduction System..... 804
- WINTERS, WILLIAM, ET AL. Use of Intravascular Carbon Dioxide Gas to Demonstrate Interatrial Septal Defects..... 804
- CHANG, C. H. (JOSEPH), AND ROGERS, JAMES V., JR. Cor Triatriatum Sinistrum..... 805
- DAVIES, PAGET, AND BUCKY, N. L. Tomography of Calcified Aortic and Mitral Valves..... 805
- SAYMAN, ISMET. A New Kymographic Sign of Myocardial Infarct: Dissociation of Kymographic Layers..... 805
- FELL, STANLEY C., ET AL. Congenital Diverticula of the Pericardium..... 806
- GIMLETTE, T. M. D. Constrictive Pericarditis..... 806
- CAMPETI, FRANK L., ET AL. Dynamics of the Orifices of the Venae Cavae Studied by Cineangiography..... 806
- KUZMAN, WILLIAM J., ET AL. Anomalous Left Coronary Artery Arising from the Pulmonary Artery..... 806
- LEMMON, WILLIAM M., ET AL. Suprasternal Transaortic Coronary Arteriography..... 807
- LANG, ERICH K., ET AL. Angiocardiographic Features of the Bland-White-Garland Syndrome..... 807
- FOGEL, MARIA, ET AL. Transposition of the Pulmonary Veins..... 807
- GREEN, HENRY. A Fluoroscopic Sign of Pulmonic Stenosis..... 808
- LIVERUD, KJELL. Occluding Dissecting Aneurysm as a Complication of Carotid Angiography..... 808
- LIVERUD, KJELL. Technique in Percutaneous Carotid and Vertebral Angiography with Polyethylene Catheters..... 808
- SALTZMAN, GEORG-FREDRIK. Circulation Through the Posterior Communicating Artery in Different Compression Tests. A Preliminary Report..... 808
- ÖDMAN, PER. Percutaneous Selective Angiography of the Superior Mesenteric Artery..... 809
- HARROW, BENEDICT R., AND SLOANE, JACK A. Aneurysm of Renal Artery: Report of Five Cases..... 809
- EDLING, N. P. G., AND HELANDER, C. G. Nephrographic Effect in Renal Angiography. An Experimental Study in Dogs..... 809
- BOTSEAS, D. S., AND LAWRENCE, G. H. Skin Necrosis Complicating Femoral Arteriography..... 809



- MATHIESEN, FRITS R. Clinical Manifestations of Primary Varicose Veins. I. An Evaluation of Some Phlebographic Findings in the Deep Veins. . . . . 809

### The Digestive System

- VANTRAPPEN, GASTON, ET AL. Simultaneous Fluorocinematography and Intraluminal Pressure Measurements in the Study of Esophageal Motility. . . . . 810
- MARUYAMA, YOSH, ET AL. Acquired Esophago-tracheal Fistula Secondary to a Foreign Body in the Esophagus. . . . . 810
- POPOV, S. N., AND KARMANOVA, Z. YA. Chronic Antral Gastritis as a Precancerous Condition. . . . . 810
- WAGSTAFF, JOHN K. Clinical Diagnosis in Gastrointestinal Hemorrhage. A Planned Investigation Including Arteriographic Studies of the Human Stomach. . . . . 810
- PATTINSON, J. N., AND OSBORNE, G. Benign Lesions of the Pyloric Antrum Simulating Carcinoma. . . . . 811
- SKORYSA, STANLEY C., ET AL. Development of Primary Pyloric Hypertrophy in Adults in Relation to the Structure and Function of the Pyloric Canal. . . . . 811
- TAYLOR, E. E. T. Duodenal Megabulbus and Annular Pancreas. . . . . 811
- BOOTH, C. C., ET AL. Intestinal Hypertrophy Following Partial Resection of the Small Bowel in the Rat. . . . . 812
- SINGLETON, EDWARD B. Radiologic Considerations in Diagnosis and Treatment of Intussusception. . . . . 812
- MESTEL, A. L., ET AL. Acute Obstruction of Small Intestine Secondary to Hematoma in Children. . . . . 812
- MESTEL, A. L. Lymphosarcoma of the Small Intestine in Infancy and Childhood. . . . . 812
- MARTIN, JOHN A. Colon Preparation for Radiological Studies Using a New Drug. . . . . 813
- ALLEN, WM. E., JR. Hypaque Sodium Powder. A New Gastrointestinal Opaque. . . . . 813
- ROSE, J. DUDFIELD. Serial Cholecystography. A Means of Preoperative Diagnosis of Biliary Dyskinesia. . . . . 813
- JOHNSON, HENRY C., JR., ET AL. Diagnostic Value of Intravenous Cholangiography During Acute Cholecystitis and Acute Pancreatitis. . . . . 814
- SALZMAN, EMANUEL, ET AL. Opacifying Gallstones. . . . . 814
- HANKAMP, LAMAR J. Congenital Choledochal Cyst. Demonstration by Oral Cholecystography. . . . . 814

### The Musculoskeletal System

- BUCKY, N. L. Bone Infarction. . . . . 815
- KOLÁR, JAROMÍR, AND VRABEC, RADKO. Peri-

- articular Soft-Tissue Changes as a Late Consequence of Burns. . . . . 81
- TAUSEND, M. E., AND MARCUS, MILTON. Solitary Unicameral Bone Cyst in a Seven-Week-Old Infant. . . . . 815
- DIAMOND, MONROE T. The Syndrome of Exophthalmos, Hypertrophic Osteoarthropathy and Localized Myxedema: Review of Literature and Report of a Case. . . . . 816
- FRIEDENBERG, Z. B., ET AL. Degenerative Changes in the Cervical Spine. . . . . 816
- KNUTSSON, BERTIL, AND WIBERG, GUNNAR. On Surgically Treated Herniated Intervertebral Discs. . . . . 816
- NORDLANDER, SVERKER, ET AL. Discography in Low Back Pain and Sciatica. Analysis of 73 Operated Cases. . . . . 817
- RODMAN, THEODORE, ET AL. Sarcoidosis with Vertebral Involvement. . . . . 817
- HULTH, ANDERS. Circulatory Disturbances in Osteoarthritis of the Hip. A Venographic Study. . . . . 817
- HOWORTH, BECKETT. Coxa Plana. . . . . 818
- STØREN, GUNNAR. Traumatic Dislocation of the Radial Head as an Isolated Lesion in Children. Report of One Case with Special Regard to Roentgen Diagnosis. . . . . 818
- PHILIPPON, J. Study of Congenital Meniscal Malformations by Pneumarthrography. . . . . 818
- LEVINE, JACK, ET AL. Non-Union of a Fracture of the Anterior Superior Process of the Calcaneus. Case Report. . . . . 818

### The Spinal Cord

- PERESE, D. M., ET AL. Postoperative Dissemination of Astrocytoma of the Spinal Cord Along the Ventricles of the Brain. A Case Report. . . . . 818
- BUNNER, ROLAND. Lateral Intrathoracic Meningocele. . . . . 819

### Gynecology and Obstetrics

- REISS, H. E., AND GROSSMANN, MARIA E. Experience with New Contrast Media for Hysterosalpingography. . . . . 819

### The Genitourinary System

- HUTCH, JOHN A., ET AL. Perirenal (Gerota's) Fascitis. . . . . 819
- BROWNING, WILLIAM H., ET AL. Delayed Cystography: A Valuable Diagnostic Tool. . . . . 820
- GODDARD, DAVID W. Experiences with Thixokon: The New Urethrographic Medium. . . . . 820
- WINTER, CHESTER C. A New Test for Vesicoureteral Reflux: An External Technique Using Radioisotopes. . . . . 820
- BENJAMIN, JOHN A. The Use of X-Ray Cinematography in Urological Studies. . . . . 820
- HINMAN, FRANK, JR., AND OPPENHEIMER, RUDOLF. Functional Characteristics of the Ileal Segment as a Value. . . . . 820

- MUELLNER, S. RICHARD. The Voluntary Control of Micturition in Man..... 821

# Miscellaneous

- BELLMAN, SVEN, AND ODÉN, BO. Regeneration of Surgically Divided Lymph Vessels. An Experimental Study on the Rabbit's Ear... 821
- DONNAN, M. G. F. Torulosis..... 822

# Technic

- CANDARDJIS, G., AND BUGNION, M. Current Indications for Roentgen Cinematography.... 822

# RADIOTHERAPY

- REESE, A. B., ET AL. The Treatment of Retinoblastoma by X-Ray and Triethylene Melamine..... 822
- RIEMENSCHNEIDER, PAUL A., AND PRIOR, JOHN T. Neuroblastoma Originating from Olfactory Epithelium (Esthesioneuroblastoma)..... 823
- REEVES, ROBERT J. Treatment of Hemangioma of Infants and Young Children..... 823
- PARKER, ROBERT C. Carcinoma of the Nasal Fossa..... 823
- SHELIN, GLENN E., ET AL. Radiation Therapy for Cancer of the Tonsil..... 824
- SCANLON, PAUL W., ET AL. Carcinoma of the Palatine Tonsil..... 824
- KIEFER, EVERETT D., AND SMEDAL, MAGNUS I. Radiation Therapy for Stoma Ulcer Occurring After Subtotal Gastrectomy..... 825
- WANG, C. C., ET AL. Carcinoma of the Sigmoid Colon: Report of Two Inoperable Cases with Favourable Results Five or More Years Following Radiation Therapy..... 825
- LATTIMER, JOHN K., ET AL. Wilms Tumor: A Report of 71 Cases..... 825
- BRACK, C. BERNARD, ET AL. Neoplasms of the Female Urinary Bladder..... 826
- FLATMAN, G. E. Some Observations on the Treatment of Certain Radio-resistant Tumours..... 826
- DAHL, OLOV, AND VIKTERLÖF, KARL J. Dose Distributions in Arc Therapy in the 200 to 250 kv Range: Systematic Measurements in Homogeneous Phantoms with the Beam Direction Perpendicular to the Oscillation Axis..... 827
- BOAG, J. W., ET AL. Radiation Dosimetry by Transparent Plastics..... 827
- DOLPHIN, G. W., ET AL. Investigations of High Energy Electron Beams for Use in Therapy..... 828
- EVANS, E. ANN. A Method for Construction of Isodose Charts from Minimum Experimental Data..... 828

# RADIOISOTOPES

- CLARKE, K. H., ET AL. Radioiodine Tracer Tests in the Diagnosis of Hyperthyroidism..... 828

- HAMOLSKY, MILTON W., ET AL. The Plasma Protein-Thyroid Hormone Complex in Man. III. Further Studies on the Use of the in Vitro Red Blood Cell Uptake of  $I^{131}$ -L-Triiodothyronine as a Diagnostic Test of Thyroid Function..... 829
- KURLAND, GEORGE S., ET AL. Thyroid Function in Supraventricular Tachycardias: Turnover of Intravenously Infused  $I^{131}$ -Labeled Thyroxine and the Red Blood Cell Uptake of  $I^{131}$ -Labeled L-Triiodothyronine..... 829
- STAFFURTH, J. S., AND BIRCHALL, I. The Significance of the Protein-Bound Radioactive Iodine Determination in Hyperthyroidism... 830
- MILL, W. A., ET AL. Carcinoma of the Lingual Thyroid Treated with Radioactive Iodine... 830
- KENNEDY, WILLIAM M., AND FISH, ROBERT G. Acute Granulocytic Leukemia After Radioactive Iodine Therapy for Hyperthyroidism. 830
- SHELIN, GLENN E., ET AL. Occurrence of Thyroid Nodules in Children Following Therapy with Radioiodine for Hyperthyroidism..... 830
- FLOCKS, R. H., ET AL. Present Status of Radioactive Gold Therapy in Management of Prostatic Cancer..... 830
- BURKLE, JOSEPH S., AND GLIEDMAN, MARVIN L. External Recording Method for Estimating Hepatic Blood Flow with the Use of Radiogold..... 831
- BRAESTRUP, CARL B. Physical and Clinical Advantages and Limitations of Cobalt 60 Teletherapy. Part I. Physical Factors... 831
- GUTTMANN, RUTH J. Physical and Clinical Advantages and Limitations of Cobalt 60 Teletherapy. Part II. Clinical Considerations. 832
- JOHNS, H. E., AND CUNNINGHAM, J. R. A Precision Cobalt 60 Unit for Fixed Field and Rotation Therapy..... 832
- GOODWIN, PAUL N. Calorimetric Measurements on a Cesium-137 Teletherapy Unit..... 832
- AGFANAT, V. Z. Accumulation of Polonium ( $Po^{210}$ ) by Water-Living Organisms..... 833
- MAREI, A. N., ET AL. Transmission of Radioactive Strontium through Food from Open Water Reservoirs into the Human Organism. 833
- MENA, ISMAEL, ET AL. Determination of Cardiac Portal Circulation Time by External Scintillation Counting..... 833
- LESSARD, R., ET AL. Physiological Studies on Beriberi Heart Disease by Injection of Radioactive Material..... 834

# RADIATION EFFECTS

- VAN DEN BREK, H. A. S. The Radiation Hazard as It Affects Medical Practice..... 834
- SMITH, GORDON C. Radiation Hazards in Industry..... 835
- KREBS, JOHN S., ET AL. The Estimation of the Nonrecuperable Injury Caused by Ionizing Radiation..... 835

- WEENS, H. S., ET AL. Radiation Exposure of Patient and Personnel During Urographic Procedures..... 836
- MARTIN, J. H., AND EVANS, ANN. Radiation Outside the Defined Field..... 836
- JOHNSON, ADRIAN. Practical Radiation Protection..... 836
- CRAM, R. W., ET AL. Tolerance of Skin Grafts to Radiation: A Study of Postmastectomy Irradiated Grafts..... 836
- PARKINSON, JOHN E. Effect of Internal Emitters on Red Cell Survival in Beagle Dogs.... 836
- BOND, V. P., AND EASTERDAY, O. D. Effects of Heavy Particle Irradiation on Acute Mortality and Survival Time in the Mouse..... 837
- DE VRIES, M. J., AND VOS, O. Treatment of Mouse Lymphosarcoma by Total-Body X Irradiation and by Injection of Bone Marrow and Lymph-Node Cells..... 837
- BAKER, D. G., AND HUNTER, C. G. The Early Gastrointestinal Response in the Rat Exposed to Whole-Body X-Irradiation..... 837
- NEWSOM, BERNARD D., AND KIMELDORF, DONALD J. Role of Food Consumption in the Mortality Response of Irradiated Rats Subjected to Prolonged Cold Exposure..... 838
- JACKSON, KENNETH L., AND ENTENMAN, CECIL. The Role of Bile Secretion in the Gastrointestinal Radiation Syndrome..... 838
- WOOLLAM, D. H. M., ET AL. The Influence of Cortisone on the Teratogenic Activity of X Radiation..... 838
- KLEMPARSKAYA, N. N., ET AL. Biological Effect of the Cellular Structures in Normal and Irradiated Rabbits..... 838
- YANDERS, ARMON F. The Effect of Dose Rate on Genetic Damage from Fast Electrons in *Drosophila* Sperm..... 838



Pneu  
Position  
surg. 10  
School  
In or  
pneum  
—less t  
were ex  
off and  
To th  
added  
astride  
If the p  
flexed s  
with th  
tentori  
meatal  
zontal.  
via the  
over a p  
and late  
almost  
magna,  
posterior  
sufficient  
permit a  
eate the  
meters  
develop  
injected  
gradual  
resulted  
This  
in age  
patients  
In all ca  
Seventy  
twenty-  
This w  
graphic  
Ten

Our  
the Dee  
Lesions  
Fortsch  
Decemb  
Akadem  
slovakia  
One  
with 10  
space-oc  
In 90  
correctly  
reference  
gram wa  
gram, an  
The v  
zation o  
methods  
of the d  
The v

## ROENTGEN DIAGNOSIS

### THE HEAD AND NECK

**Pneumoencephalography with Direct Injection and Positional Directing of Air.** Mark Dyken. *J. Neurosurg.* 16: 99-106, January 1959. (Indiana University School of Medicine, Indianapolis, Ind.)

In order to test the Slosberg and Bornstein technic of pneumoencephalography (removal of a minimal amount—less than 5 c.c.—of cerebrospinal fluid), 10 patients were examined by that procedure and 10 by the Davidoff and Dyke air-fluid exchange technic.

To the method of Slosberg and Bornstein, the author added positional directing of air. The patient sat astride an ordinary chair with an adjustable chin rest. If the posterior fossa was to be studied, the head was flexed so that the orbital-meatal line formed a 50° angle with the horizontal. To visualize structures above the tentorium, the head was flexed so that the orbital-meatal line formed an angle of 25 to 30° with the horizontal. Fifteen cubic centimeters of air were introduced via the lumbar route, without withdrawal of any fluid, over a period of at least five minutes. Anteroposterior and lateral films were then taken. This volume of air almost always resulted in excellent filling of the cisterna magna, fourth ventricle, aqueduct, and most of the posterior part of the third ventricle. Furthermore, sufficient air usually entered the lateral ventricles to permit an estimate of the total amount needed to delineate these structures. Fifteen additional cubic centimeters were slowly injected while the films were being developed. These were viewed, and more air was injected if necessary. The head was then extended gradually, with a slight shaking motion, which usually resulted in adequate filling of the basal cisterns and sulci.

This procedure was performed on 60 patients, ranging in age from nine to seventy years. In the last 35 patients, the average amount of air injected was 41 c.c. In all cases, all structures of interest were demonstrated. Seventy-two per cent of patients were symptom-free in twenty-four hours, and 100 per cent in ninety-six hours. This was an impressive decrease in post-encephalographic morbidity.

Ten roentgenograms; 1 table.

EUGENE A. CORNELIUS, M.D.  
Houston, Texas

**Our Experiences with the Diagnostic Utilization of the Deep Phlebogram in Intracranial Space-Occupying Lesions.** S. Nettl, L. Steinhart, B. Dítě, and M. Kroó. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 89: 645-659, December 1958. (In German) (Militärmedizinische Akademie J. Ev. Purkyně, Hradec Králově, Czechoslovakia)

One hundred normal phlebograms were compared with 100 phlebograms in patients with intracranial space-occupying lesions.

In 90 per cent of the pathological cases, the tumor was correctly localized in the lateral projection without reference to the arteriogram. In 14 cases, the phlebogram was more valuable for localization than the arteriogram, and in 25 cases it was equally useful.

The value of previously employed methods of localization of the venous angle was studied, and additional methods of localization of this angle and other features of the deep phlebogram were devised.

The venous angle was displaced posteriorly in 10 of 12

frontal tumors. Tumors in other locations sometimes displaced it in the direction of the pressure effect of the mass, but more frequently this sign was negative. The authors' method of measuring the height of the venous angle and its distance from the tuberculum sellae was equal in value to other methods. Good results were obtained in measuring the distance of the mid-point of the curve of the internal cerebral vein to the junction of the vein of Galen in the straight sinus. This was increased in 19 of 22 posterior parietal and parieto-occipital tumors, in contrast to frontal tumors, where there was a decrease in 9 of 12. Furthermore, the distance from the venous angle to the junction of the vein of Galen in the straight sinus and to the lowest point of the vein of Galen, and the difference between these values, are significant in differentiating frontal, posterior parietal, and temporal tumors.

The sagittal projection, although of less value than the lateral projection for localization, sometimes is more useful than the sagittal arteriogram for the demonstration of an expansive process.

The superficial phlebogram can sometimes aid significantly in the diagnosis of superficial lesions.

Twelve roentgenograms; 2 diagrams; 2 tables.

EUGENE A. CORNELIUS, M.D.  
Houston, Texas

**A Rare Calcific Shadow in the Parasellar Space.** G. Thiele. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 89: 682-686, December 1958. (In German) (Medizinische Universitäts-Poliklinik, Jena, Germany)

A paired symmetrical intracranial calcific shadow, which has been observed only in cases of "hyalinos cutis et mucosae" has received no attention in the radiologic literature.

This familial disease is a complex disturbance of the metabolism of albumin and lipoids, and probably also of carbohydrates, which leads to deposition of paraproteins in the skin and the mucosa. The oral cavity, larynx, and face are usually involved, but the flat or nodular yellowish deposits may also appear on the trunk and extremities. The condition appears in early childhood and progresses slowly. Dental anomalies, macroglossia, mental deficiency, and convulsions may be present. In addition to the intracranial calcification, disturbance of motility and mucosal coarsening of the esophagus and stomach have been demonstrated roentgenologically. In 13 of some 45 previously reported cases, roentgenograms of the skull were made. In 3 cases, the typical parasellar calcific shadows were demonstrated.

A detailed neuroradiologic account of a case in a 34-year-old man is given. There were two calcific shadows on each side of the sella turcica, which were bilaterally symmetrical. They were sharply demarcated, homogeneous, and dense. In the lateral projection, they were superimposed on the dorsum sellae and projected above it. In the occipitofrontal projection, the shadows were on the level of the orbital roof about 2 to 3 cm. lateral to the midline. Their configuration was best demonstrated by laminagrams in the coronal plane. The medial and inferior calcific densities resembled angels' wings. The other two shadows were half-moon shaped, with the convexity directed superolaterally. They closely adjoined the medial densities. On arteriograms, these shadows were far lateral to the carotid siphon. The

appearance was similar to that in the previous cases.

The calcifications were presumed to be located in the meninges and in the adjoining temporal lobe. There is thus a parallelism with Sturge-Weber syndrome, which also involves skin and brain.

Four roentgenograms.

EUGENE A. CORNELIUS, M.D.  
Houston, Texas

**Avoidance of False Angiographic Localization of the Site of Internal Carotid Occlusion.** Francis Murphey and John Shillito, Jr. *J. Neurosurg.* 16: 24-31, January 1959. (University of Tennessee College of Medicine, Memphis)

Accurate demonstration of the site and extent of an occlusive mass in the internal carotid artery is essential when surgical removal is contemplated. Angiographic demonstration of the point of occlusion in the cervical portion of the artery is not difficult. Usually the opaque column ends bluntly or there is complete nonfilling of the internal carotid artery. An opaque column tapering gradually to a slender point in most instances represents the advancing medium proceeding toward an obstruction higher in the artery, usually in the intracranial portion. The slow progression of the medium is presumably made possible by incomplete obstruction or by slow run-off via a patent ophthalmic artery proximal to the site of obstruction. In a completely occluded segment containing as yet unclotted blood, mixing of the medium from the force of injection must occur.

By making greatly delayed (up to six seconds) serial lateral exposures, the proximal ends of complete or nearly complete obstructions have been accurately localized.

Four illustrative cases are presented.

Nine roentgenograms; 9 sketches.

EUGENE A. CORNELIUS, M.D.  
Houston, Texas

**Scleroma of the Upper Air-Passages: A Clinico-radiological Study of 84 Cases.** G. E. Massoud and H. K. Awwad. *J. Fac. Radiologists* 10: 44-49, January 1959. (University of Alexandria, Egypt)

Scleroma is a granuloma mainly affecting the nose, but occasionally involving the upper air passages, trachea, and bronchi. The causative organism is thought to be a strain of Friedländer's bacillus; the mode of infection is unknown. The condition is endemic in Eastern Europe, Russia, South America, certain Far Eastern islands, and Egypt.

Eighty-four cases from Egypt, chiefly from rural areas, are reported here. The sexes were equally affected. The age range was from twelve to fifty-eight years. The initial symptoms were usually those of nasal obstruction, most often unilateral, and bleeding. Only 10 cases involved the larynx, and in these change of voice was the most frequent manifestation.

The radiographic signs are thickening of the nasal mucosa, expansion of the nasal cavity, and occasional bony sclerosis. Tumor-like involvement of the sinuses may occur. Atrophic rhinitis may be the end result.

Treatment is mainly by irradiation. Antibiotics appear to be effective only against secondary infection. The x-ray dosage level found most desirable is 1,500-2,000 r in three to four weeks. Lower dosage was not effective in most cases. Higher dosages (3,000-4,000 r) caused undesirable pigmentation, depigmentation, and telangiectasis. Response to treatment is good and

almost uniform. Only one relapse was noted in patients who were relieved for one year or more after a single course of irradiation.

Eleven roentgenograms; 5 photographs; 5 tables.  
MAJ. NEIL E. CROW, M.C.  
Lackland AFB, Texas

**Sphincteric Action of Crico-pharyngeus: Radiographic Demonstration.** A. P. Fuller, J. A. F. Fozzard, and G. H. Wright. *Brit. J. Radiol.* 32: 32-35, January 1959. (Department of Anatomy, University of Cambridge, Cambridge, England)

The authors present results of radiographic demonstration of the sphincteric action of the cricopharyngeus muscle. Their study was initiated when it was observed that there seemed to be a tendency of the gullet to extrude a tube inserted for the purpose of injecting fluids into the hypopharynx and esophagus when the lower end of the tube was pulled up to a critical level, roughly opposite the sixth cervical vertebra.

Ten healthy medical student volunteers were utilized for the study. An india-rubber Ryle's stomach tube, passed through the nose, was used. The tube was marked for measurement.

Lateral roentgenograms of the neck were made and from these studies the authors concluded that the cricopharyngeus muscle is in a state of tonic contraction except during the act of swallowing. If the resting intraluminal pressure is considerably higher in this part of the gullet than either above or below, it is not surprising that any object lodging in this critical area tends to be squeezed out of it, either downward by swallowing or upward by regurgitation. Extrusion of the tube from the nose occurs as a result of contraction of the muscle and, if extrusion from the nostril is prevented, the tube is bowed superiorly. If the object in the pharynx is enlarged and incompressible, such as the end of a Ryle's tube, and the tube is held at the nostril, swallowing is not possible. The squeezing of the end of the tube, upward out of the critical region, is associated with a sensation of regurgitation that is not accompanied by any feeling of nausea.

The observations reported here accord well with the idea that the cricopharyngeus acts as a sphincter.

Two roentgenograms; 3 diagrams.

THEODORE E. KEATS, M.D.  
University of Missouri

**The Radiological Appearances of the Soft Palate with Reference to the Treatment of Cleft Palate.** Rodney I. Green. *J. Fac. Radiologists* 10: 27-39, January 1959. (Liverpool United Hospitals, Liverpool, England)

A simple technic for visualizing radiographically the soft palate and surrounding soft-tissue structures is described. The information thus afforded is useful in cases in which operation for cleft palate is contemplated and in indicating the need of further surgery if closure is not achieved at the initial procedure.

Lateral soft tissue radiographs centered over the temporomandibular joints are taken during quiet breathing and during the production of certain isolated sounds. From these can be deduced the length and thickness of the soft palate, its ability to close against the posterior pharyngeal wall, and the relative depth of the nasopharynx. Also, the presence or absence of a horizontal muscular ridge or adenoid pad, as an aid in secondary closure, can be ascertained.



The normal and postsurgical appearances of the soft palate are reviewed.

Thirty-six roentgenograms; 2 diagrams.

CAPT. HARRIS W. KNUDSON, M.C.  
Lackland AFB, Texas

**Spontaneous Dislocation of the Atlanto-axial Articulation Occurring in Ankylosing Spondylitis and Rheumatoid Arthritis.** T. L. C. Pratt. J. Fac. Radiologists 10: 40-43, January 1959. (Halifax and Huddersfield Hospital Groups, West Riding, Yorkshire, England)

The author reviews the scanty literature (55 cases) of atlanto-axial dislocation from ankylosing spondylitis and rheumatoid arthritis and reports 3 new examples (2 of ankylosing spondylitis and 1 of rheumatoid arthritis). The complication can result from acute or chronic infection. Atlas decalcification as a result of hyperemia, leading to detachment of the transverse ligament, is believed to be the cause. Awareness of the possibility of atlanto-axial dislocation in ankylosing spondylitis and rheumatoid arthritis is of importance. It can occur at any time in the active course of the disease.

In any case of spontaneous atlanto-axial dislocation without apparent clinical cause, the whole spine and the sacroiliac joints should be examined radiologically for evidence of ankylosing spondylitis. In proved cases of the latter disease radiology is indicated when the patient complains of pains in the neck, particularly if the head is becoming flexed.

Five roentgenograms.

LIEUT. COL. H. N. STURTEVANT, M.C.  
Lackland AFB, Texas

## THE CHEST

**Normal and Pathologic Pulmonary Segments in the Selective Angiogram.** Hh. Löhr, H. Scholtze, and W. Grill. Acta radiol. 51: 33-51, January 1959. (In German) (Chirurgische Universitätsklinik, Marburg-Lahn, West Germany)

The authors introduce their paper by a lengthy historical review of the literature dealing with the problems of selective pulmonary angiography in the healthy and diseased lung. Their own contribution to the subject is divided into two parts. In the first, the normal anatomy of segmental arteries noted during angiography is described in great detail, the international nomenclature being employed. In the second part, the most important pathological changes observed in various localized and generalized diseases are described. The paper is based on clinical experience gained by examining 250 patients, of whom 84 were operated upon.

The technique of the angiographic procedure is described in detail and its value in the functional assessment of an individual segment in cases of proposed segmental resection is emphasized. The pathological findings in all the segmental arteries are described and correlated with the radiologic findings.

Sixteen angiograms; 1 photomicrograph; 5 diagrams.

JULIAN O. SALIK, M.D.  
Baltimore, Md.

**Possible Disadvantages of a Chest Radiography Service for General Practitioners.** Peter Stradling and W. M. Dixon. Brit. M. J. 2: 1383-1385, Dec. 6, 1958. (Hammersmith Chest Clinic, London, England)

The authors report a study which leads them to the

conclusion that the possible disadvantages of a radiographic service provided by a chest clinic for the general practitioner are largely theoretical and are not borne out in actual practice. They sought to determine, in those patients whose chest radiographs were reported as normal, (a) the amount of clinically discoverable disease present on attendance, (b) the incidence of early disease missed on radiography as represented by its appearance within the next few months, and (c) the extent to which normal x-ray reports influenced practitioners in their appreciation of any subsequent development.

Clinical examinations were made of 74 patients, chosen by a systematic sampling method from a group referred for "x-ray only." The thoracic abnormalities so discovered in those with normal chest radiographs represented 5.4 per cent of the sample. Another 6.7 per cent had non-thoracic diseases detected by clinical but not by radiological examination.

Another sample with negative minifilms was studied four to eight months later by questionnaires to the patients' physicians. Of 61 such patients, the practitioners had considered 48 normal and had made definite diagnoses, such as bronchitis, in 12. In none had further disease developed in the follow-up period. In 1 instance a symptomatic carcinoma of the bronchus was subsequently diagnosed.

The authors conclude that the freely available chest radiography service for general practitioners is of great value, as indicated by high yield of initial abnormalities, low yield of disease on additional physical examination, and absence of serious developments during a period of follow-up.

GARTH R. DREWRY, M.D.  
Tampa, Fla.

**Role of Photofluorography in Navy Tuberculosis Control.** John F. Chace and E. P. Coffay, Jr. Dis. of Chest 35: 22-29, January 1959. (Bureau of Medicine and Surgery, Navy Department, Washington 25, D. C.)

The authors report a study conducted to determine how effective a contribution routine photofluorographic screening makes to the Tuberculosis Control Program of the U. S. Navy. Routine photofluorographic examinations of the chest are made of both military and civilian personnel on entering and leaving the service, and at annual intervals when practicable. If findings are suspicious, re-examination is done on 14 X 17-inch film. A second reading of the 70-mm. films is made within a month by the Tuberculosis Control Section of the Navy Bureau of Medicine and Surgery, in Washington, D. C. If a 70-mm. film is found suspicious on the rereading, a request for follow-up is made wherever the individual is stationed. Tuberculosis cases are isolated and treated in naval hospitals at St. Albans, Long Island, or San Diego, Calif. Reports from these two hospitals, covering a period of a year, were analyzed.

Of 301 new cases of tuberculosis, 111 (37 per cent) were admitted because of symptoms, 168 (56 per cent) because of routine 70-mm. photofluorographic findings, and 22 (7 per cent) for other reasons unrelated to the chest. Of the 168 cases, 24 (14 per cent) represented enlistments, 31 (18 per cent) separation from Service, 11 (7 per cent) re-enlistment, and 102 (61 per cent) routine periodic examinations. Of the 301 persons, all but 41 (14 per cent) had had an x-ray examination of the chest within two years, and 225 had had a negative chest reading within eighteen months. Of the 168 enlistment cases, 150 were detected on the first reading and 18 on the second.

Photofluorographic examination is considered a satisfactory method for tuberculosis detection; repeated survey studies are necessary to discover cases developing while in service.

The 18 cases (11 per cent) in this series detected on second reading represents a human error (lower than the average reported for intramural and extramural re-reading, which is approximately 25 per cent).

Four tables.

HENRY K. TAYLOR, M.D.  
New York, N. Y.

**Pulmonary Alveolar Microlithiasis.** W. R. Cole. *J. Fac. Radiologists* 10: 54-56, January 1959. (Perth, Western Australia)

Pulmonary alveolar microlithiasis is a rare condition characterized by the formation of tiny calculi in the pulmonary alveoli. The etiology of the disease is not known.

The radiological changes are the outstanding feature of the disorder and are strikingly disproportionate to the minimal respiratory symptoms. A generalized fine, dense, miliary mottling is seen throughout the lungs, heaviest at the bases and hili. The shadows may coalesce to form apparent larger opacities, but the individual nature of the tiny calculi may be appreciated with a magnifying glass. A thin white line may be seen over the subpleural surfaces of the lungs due to concentration of the calcospherites in these areas. There is no hindrance to the normal movement of intrathoracic structures.

Initially, clinical findings are nonexistent or negligible. The disease is slowly progressive, however, and in later stages there may be pulmonary insufficiency, cough, emphysema, sputum production, and clubbing. The patient may finally die of right heart failure or actual loss of breathing capacity due to alveolar filling by the calculi.

A familial tendency has been demonstrated [see, for example, Esguerra Gomez *et al.*: *Radiology* 72: 550, 1959], but no sexual or racial predominance has been shown. Age extremes of six and seventy-two years have been reported, but the patients are usually thirty to fifty years old.

The author reports a representative case in a 45-year-old Jamaican female.

Two roentgenograms.

MAJ. BYRON G. BROGDON, M.C.  
Lackland AFB, Texas

**Lung Changes in the Recent Influenza Epidemic.** Raymond W. Galloway and Ronald S. Miller. *Brit. J. Radiol.* 32: 28-31, January 1959. (Fazakerley Hospital, Liverpool, England)

The authors report their experience with lung changes in the recent influenza epidemic. Four hundred and six patients with influenza or pulmonary complications from influenzal infection were admitted to their hospital between mid-June and early November 1957; 193 had clinical signs of pneumonia and, of these, 112 had radiologically demonstrable lung changes. These changes comprised:

- (a) Patchy bronchopneumonic consolidation, predominantly basal, unilateral or bilateral.
- (b) Lobar and segmental consolidation.
- (c) Pleural effusions.
- (d) Lung abscess.
- (e) Incidental findings, including 4 cases of active pulmonary tuberculosis.

In the series 33 deaths occurred and *Staphylococcus aureus* was isolated from a large percentage of these, either from the sputum or from lung tissue at post-mortem.

Nine roentgenograms; 1 table.

THEODORE E. KEATS, M.D.  
University of Missouri

**Some Less Familiar Roentgen Manifestations of Intrathoracic Histoplasmosis.** Benjamin Felson. *Arch. Int. Med.* 103: 54-62, January 1959. (Cincinnati General Hospital, Cincinnati 29, Ohio)

For the most part, the varied roentgen manifestations of histoplasmosis fall into three main categories: (1) an acute disseminated form with miliary or small patchy densities diffusely distributed throughout the lungs, sometimes encountered in epidemics, (2) a localized pneumonic form, and (3) the solitary nodule of chronic and asymptomatic nature. Each of these types may be associated with hilar and/or mediastinal lymph node enlargement of variable degree. In some cases the lymph node enlargement may be the sole roentgen manifestation of the disease.

These findings, however, are by no means the only ones encountered. Some of the less familiar roentgen patterns are discussed in this paper. *Fibrovascular histoplasmosis* is probably less rare than generally believed, the author himself having seen 5 cases. This form of the disease is seen chiefly among elderly men, and symptoms and signs closely simulate those of active chronic fibroid tuberculosis. Usually there is fibrotic involvement of one or both upper lobes, with hilar elevation, retraction, and displacement of mediastinal structures. Cavitation is a prominent feature. The process may remain stationary or even regress, but more often there is slow progression with involvement of more and more lung parenchyma and ultimately death. Occasionally tuberculosis and histoplasmosis coexist.

*Pulmonary histoplasmosis* is generally regarded as an inactive lesion; on occasion, however, a histoplasmosis, even though it may show calcification, will enlarge slowly. These cases are exceptional. The vast majority of histoplasmoses remain unchanged over prolonged periods of observation and are culturally sterile and histologically quiescent.

Multiple histoplasmoses can occur. The author encountered 5 asymptomatic patients with multiple large nodules up to 3 cm. in diameter. In each instance some of the nodules contained calcium, although tomography was at times necessary for its demonstration. The nodules remained stationary in 3 and became smaller in the other 2 cases. In all 5 the histoplasmin skin test was positive and 3 had negative tuberculin tests. It seems reasonable that at least some of this group represent histoplasmosis.

There may be a number of sequelae to long-standing histoplasmic lymphadenitis. It has been generally assumed that broncholithiasis from a calcific focus eroding into the bronchus is due to quiescent tuberculosis, but this is not always so. A case is reported in which *H. capsulatum* could be demonstrated in the calcified broncholith.

Middle-lobe syndrome is usually attributed to compression of the bronchus by chronic inflammatory change in adjacent nodes. The term is a misnomer, since almost any lobar or segmental bronchus may, on occasion, be similarly affected. The author's belief is well supported that, in the endemic area in which he

practices lymphadenitis, reasoning that chronic fibrosis contracts particularly phageal. The author with barium all patients those with such nodules cer and must be which a merely en Eleven

Dermat Goldfish 206, Jan 67, N. Y. The author man with findings of the disease pneumonitis was noted dermatitis and swelling, and showed retention. The child showed lesions in areas in which similar to notably polyarteritis lungs revealed cholelith. Skin, keeping dermatitis showed muscle, l. stial pneumonia and emphysema cor pulmonis. Two roentgenographs.

Bronch E. Gilbride thorac. 1. Bronchopulmonary bronchitis, followed by malnutrition, cate cancer.

practices, histoplasmosis is usually the cause of the lymphadenitis underlying this chronic collapse. Similar reasoning may be applicable to the rare instances of chronic superior vena caval obstruction resulting from fibrous or calcific mediastinitis. Another sequel is the contraction of fibrous tissue in and around the nodes, particularly in the carinal region, resulting in esophageal diverticulum.

The author makes it a rule to examine the esophagus with barium for mediastinal lymph node enlargement in all patients with slowly resolving pneumonia, as well as those with a dense or enlarged hilus. Demonstration of such nodal enlargement—a not infrequent event—is followed by study for histoplasmosis as well as for cancer and tuberculosis. In endemic areas histoplasmosis must be given serious consideration in all instances in which a diagnosis of pulmonary tuberculosis was formerly entertained.

Eleven roentgenograms.

CHARLES M. GREENWALD, M.D.  
Iowa City, Iowa

**Dermatomyositis with Pulmonary Lesions.** Jerome Goldfischer and Eli H. Rubin. *Ann. Int. Med.* **50**: 194-206, January 1959. (Montefiore Hospital, New York 67, N. Y.)

The authors report the case of a 62-year-old white man with symptoms, physical signs, and laboratory findings characteristic of dermatomyositis. The course of the disease at the onset was featured by an atypical pneumonia. Thirty days after hospital admission it was noted that the patient had an extensive exfoliative dermatitis. He also experienced difficulty in chewing and swallowing, hoarseness, weakness of the extremities, and stiffness of the hands. Roentgen examination showed interference in the swallowing mechanism, with retention of barium at the esophagogastric junction.

The chest films in the initial stages of the disease showed bilateral patchy infiltrations with conglomerate areas in the right midlung region. Later the infiltrations became more diffuse, stringy, and interstitial, similar to the lesions seen in the other collagen diseases, notably scleroderma, systemic lupus erythematosus, polyarteritis, and rheumatoid disease. In time, the lungs revealed diffuse interstitial fibrosing lesions, bronchiolectasis, and emphysema.

Skin, muscle, and lung biopsies revealed changes in keeping with a systemic disturbance of the nature of dermatomyositis. The postmortem examination showed dermatomyositis with involvement of skin, muscle, heart, and esophagus; diffuse organizing interstitial pneumonitis; pulmonary arteritis, bronchiectasis and emphysema; interstitial myocardial fibrosis, and cor pulmonale.

Two roentgenograms; 3 photomicrographs; 1 photograph.

THEODORE E. KEATS, M.D.  
University of Missouri

**Bronchopulmonary Complications Revealing an Unrecognized Megaesophagus.** J. Le Melletier, L. René, E. Gilbrin, and T. R. Caulet. *J. franç. méd. et chir. thorac.* **13**: 31-39, 1959. (In French) (Paris, France)

Bronchopulmonary infections are among the most important complications of megaesophagus. Tracheobronchitis, bronchopneumonia, and suppurative conditions follow aspiration, and tuberculosis may follow malnutrition. Esophagobronchial fistula may complicate cancer of the esophagus.

Four cases are presented in which the original impression was pulmonary disease, but further investigation showed an enlarged esophagus as the primary disorder. One patient had repeated pulmonary infections, the second had hemoptysis, and the third had pulmonary tuberculosis. In the fourth patient bronchopulmonary suppuration was found to be secondary to a partially obstructing carcinoma of the lower third of the esophagus. This had invaded the nearby lung. In about 4 per cent of patients with megaesophagus eventually esophageal carcinoma develops.

Six roentgenograms; 1 photograph.

CHARLES M. NICE, JR., M.D., Ph.D.  
Tulane University

**Phlebographic Study of the Mediastinum.** M. Demoulin. *J. belge de radiol.* **42**: 17-78, 1959. (In French) (Hôpital de Seraing, Seraing, Belgium)

This is an extensive paper on the phlebographic study of the mediastinum and its possible usefulness in the diagnosis and management of different disease processes. A contrast medium is injected into the median basilic vein because it is usually the largest branch in the arm and also because it leads to better opacification of the axillary vein. After premedication with Nembutal, atropine, and morphine, the vein is exposed under local anesthesia and 10 or 15 c.c. of Sclerocaine and 1 per cent Adrenalin is injected to provoke vascular dilatation. A total of 70 c.c. of 70 per cent Umbradil is injected, a first film being taken after the injection of 50 c.c. Approximately six films are obtained in six seconds.

Diagnostic signs to be noted are evidence of displacement, change of caliber, filling defects, and the presence of collateral vessels. Except for the superior part of the left lung, the lymphatic spaces of the lungs converge toward the intertracheobronchial group and hence to the right laterotracheal chain. Therefore, mediastinal phlebography should usually be performed on the right side.

Twenty roentgenograms are reproduced and many cases are reported.

CHARLES M. NICE, JR., M.D., Ph.D.  
Tulane University

## THE HEART AND BLOOD VESSELS

### Reaction of the Heart to Selective Angiocardiography.

Russell A. McFall, Andrew H. Dowdy, and Bernard J. O'Loughlin. *Am. J. Roentgenol.* **80**: 394-406, September 1958. (University of California Medical Center, Los Angeles, Calif.)

The authors consider here various traumatic factors associated with selective angiocardiography. Their material consisted of 334 cardiac catheterizations, 159 selective angiocardiographies, 23 conventional angiocardiographies, and 10 left heart punctures in human beings. Continuous electrocardiographic tracings were recorded on all subjects throughout the procedure. In addition, 64 dogs were subjected to studies designed to clarify the safe limits of the traumatizing factors involved, e.g., insertion of the catheter, the contrast medium, rate and volume of injection, and the radiation exposure required for the procedure.

The hearts of 29 patients were inspected at the time of surgery and none showed lesions attributable to any phase of selective angiocardiography. Eighteen of the patients who subsequently died came to autopsy. None of the human deaths were attributable to selec-

tive angiocardiology. Twenty-six of the experimental animals were studied at postmortem. In many of these the exaggerated procedures employed resulted in the death of the animal or would have caused severe morbidity if the animals had not been sacrificed.

Almost invariably premature ventricular contractions were produced upon passing the catheter through the right ventricular outflow tract. In no case was a ventricular fibrillation produced. In 4 patients varying degrees of heart block were momentarily noted. Reversion to normal rate and rhythm soon followed. Subendocardial hemorrhages and thrombi were found in 85 per cent of dogs in which the catheter had remained in place for one hour or longer.

Fifty per cent Miokon and Hypaque exhibited less of a systemic effect on blood pressure than did Diodrast, Neo-Iopax, or Urokon.

Permanent cardiac arrest was not seen in this series of 159 selective angiocardiology, for the most part in children. There were no fatalities or significant sequelae in the series.

Sixteen roentgenograms; 2 tracings; 4 tables.

ROBERT H. LEAMING, M.D.  
Memorial Center, New York

**Ultra-Short (Millisecond) Timing in Roentgen Diagnostic Procedures Including Angiocardiology: Comparison of Dynapulse and Impulse Timing.** Barton R. Young, Robert B. Funch, Jay W. MacMoran, Herbert M. Stauffer, and Morton J. Oppenheimer. *Am. J. Roentgenol.* 80: 375-380, September 1958. (German-town Hospital, Philadelphia 44, Penna.)

The authors report the results of a two-year evaluation of the difference in roentgenograms obtained with the dynapulse method for ultra-short (millisecond) timing and with impulse timing.

Chest roentgenograms of children were obtained with a dynapulse timer at 1/1,000 second and with an impulse timer with exposures of 1/120 and 1/60 second. The films were analyzed by four observers independently, and without knowledge of identity of the dynapulse films. No difference could be detected in detail or pulmonary markings with the two timing methods in either normal or diseased lungs.

To evaluate the effect of millisecond timing in congenital anomalies, studies were done on dogs by the two timing methods but with other factors being the same. Venous and left-sided angiocardiology were obtained, with no appreciable difference between the two techniques. With a mechanical test object, millisecond exposures "stopped" motion of 80 cm. per second, which approaches the estimated maximal rate of blood flow.

Ten roentgenograms. ROBERT H. LEAMING, M.D.  
Memorial Center, New York

**Congenital Malformation of the Cardiac Conduction System.** Arthur J. Moss, Forrest H. Adams, and Bernard J. O'Loughlin. *J. Dis. Child.* 97: 72-77, January 1959. (5830 Overhill Dr., Los Angeles 43, Calif.)

The authors report a case of congenital interruption of the cardiac conduction system, unassociated with other defects and diagnosed during life. They establish this condition as a separate clinical and pathologic entity and suggest a change from the present nomenclature of "congenital heart block" to the more appropriate term "congenital malformation of the cardiac conduction system, with or without associated gross cardiac defects."

Their patient was a 5-year-old girl who was suspected antenatally of having a complete atrioventricular block, the presence of which was confirmed by an electrocardiogram shortly after birth. Roentgenograms showed minimal but definite widening of the left border of the heart. It could not be determined which ventricular chamber was affected. The pulmonary segment was prominent, but the lung fields were normally vascularized. The electrocardiogram revealed a complete atrioventricular dissociation, the auricular rate being 110 per minute and the ventricular rate 60 per minute. There was no evidence of specific chamber hypertrophy.

Cardiac catheterization showed no evidence of shunting of blood between the two systems. The pressures, however, were elevated throughout the entire right side of the heart, as well as in the left atrium and the left superior pulmonary vein. The latter two structures had been entered by way of a foramen ovale which was believed to be functionally closed.

Selective angiocardiology confirmed the impression at catheterization that no septal defect was present. The valvular structures and ostia also appeared to be normal. Both the aortic and pulmonary trunks were moderately dilated.

There appears to be a small group of patients in whom the heart is normally formed and the dissociation is a result of an isolated microscopic lesion of the conducting system. This has been confirmed by postmortem study in other patients.

This abnormality occurring as an isolated lesion is extremely difficult, if not impossible, to diagnose during life without the aid of cardiac catheterization and/or angiocardiology studies. This entity should be differentiated from the type which is associated with other anatomic cardiac abnormalities. The physiologic alterations are such that the clinical picture of an interventricular septal defect can be closely simulated. No treatment is required for the condition, and the prognosis is probably very good.

Five figures, including 3 roentgenograms; 1 table.

THEODORE E. KEATS, M.D.  
University of Missouri

**Use of Intravascular Carbon Dioxide Gas to Demonstrate Interatrial Septal Defects.** William Winters, Michael Wilson, Dithi Chungcharoen, Herbert M. Stauffer, Thomas M. Durant, and M. J. Oppenheimer. *Am. J. Physiol.* 195: 579-585, December 1958. (Temple University, School of Medicine, Philadelphia, Penna.)

The diagnosis of an interatrial septal defect is sometimes difficult if the opening is small or oxygen differences are absent when the shunt is from right to left. The possibility of using carbon dioxide gas to demonstrate these defects was investigated in the dog. At the same time the resulting cardiovascular changes which are produced by this gas were observed and recorded. The problem of "residual bubbles" was also considered.

It was possible to detect the presence of the experimental interatrial defect by two intracardiac criteria. When carbon dioxide gas was injected via a femoral vein or into the right heart and its large tributary veins, gas was detected shortly afterward in the left atrium briefly, and as a "residual bubble" in the left ventricle for periods up to ten to fifteen seconds. During these tests dogs were in the supine position. In either lateral position the spine shadow was of such density that a

large and quired.

The radial atrial de intravenous regardless shunts stu gas passed atrium and in the opp pulmonary tions were perior or in

In at le through th left atrium cating with atrial rath

Seventy dogs, with from 3 to 10 vided adeo technics or the image

At the defect the defect the systolic pr blood press elevates p meters of interatrial

With the dioxide wa grade cath and aorta. residual bubb ide was dis up to two n the head e

zontal, per aorta. Co introductio "residual b control va

Six figur

Cor Tri and James 413, Septe Atlanta, G

The aut triatriatum

Cor tria ially in whi atrium int congenital septal defe represents be incorpo acceptable

The roen ever, a pro always pre ary artery frequent fo monary co the author



large and dangerous increase in x-ray energy was required.

The radiologic demonstration of experimental interatrial defects by injection of carbon dioxide gas either intravenously or into the right heart was successful regardless of the direction of the shunt. Most of the shunts studied were from left to right. In these the gas passed easily from the right atrium into the left atrium and left ventricle, despite the prevalent shunt in the opposite direction as established by the fact that pulmonary arterial or right ventricular oxygen saturations were higher than those observed in either the superior or inferior vena cava.

In at least one experiment gas was seen passing through the dorsal portion of the heart from right to left atrium before appearing in the left ventricle, indicating without doubt that the defect was indeed interatrial rather than interventricular.

Seventy-nine experiments were carried out in 29 dogs, with no fatalities. Doses of carbon dioxide gas from 3 to 12 c.c./kg. were used. The smaller doses provided adequate visualization by cinematographic x-ray technics or direct observation of the output phosphor of the image intensifier.

At the time the gas passes through the interatrial defect the system pressure rises. In the absence of a defect the systemic pressure falls. Left ventricular systolic pressure levels parallel the changes in systemic blood pressure. The presence of gas in the right atrium elevates pressure in the left atrium only a few millimeters of mercury in controls and in the presence of interatrial defects.

With the dog in the supine position, gaseous carbon dioxide was delivered into the left ventricle *via* retrograde catheter introduced by way of the carotid artery and aorta. Careful observation was made of the "residual bubble" remaining after most of the carbon dioxide was discharged into the aorta. At intervals varying up to two minutes after injection in different experiments the head end of the dog was raised to 35° from the horizontal, permitting all residual gas to escape into the aorta. Continuous cardiovascular examinations during introduction of the carbon dioxide and discharge of the "residual bubble" disclosed very little departure from control values.

Six figures.

**Cor Triatriatum Sinistrum.** C. H. (Joseph) Chang and James V. Rogers, Jr. *Am. J. Roentgenol.* **80**: 407-413, September 1958. (Emory University Hospital, Atlanta, Ga.)

The authors review the literature concerning cor triatriatum sinistrum and add 1 case report.

Cor triatriatum sinistrum is a rare congenital anomaly in which a fibromuscular septum divides the left atrium into two chambers. The common associated congenital defects are patent foramen ovale and atrial septal defect. Griffith's suggestion that the condition represents the failure of the common pulmonary vein to be incorporated into the left atrium seems to be the most acceptable theory at present.

The roentgen findings are not usually specific. However, a prominent pulmonary artery segment is almost always present. Dilated hilar branches of the pulmonary artery and right ventricular enlargement are also frequent features. The lung fields usually show pulmonary congestion or edema. In the case reported by the authors, the heart was markedly enlarged, with

evidence of enlargement of the right atrium and right ventricle but not of the left atrium. There were severe pulmonary congestion and edema. In addition, there was a prominent pulmonary artery segment with enlarged hilar branches of the pulmonary artery.

Clinically respiratory embarrassment secondary to congestion with subsequent right ventricular failure is the most prominent feature of all cases with symptoms. Cyanosis is absent or only intermittent until the patient succumbs to rapidly developing cardiac failure.

In infancy the malformation is to be differentiated from other causes of cardiac enlargement and cardiac failure, especially with obscure pulmonary hypertension. Chief among the conditions calling for differentiation are: (1) congenital valvular disease; (2) primary myocardial disease; (3) anomalous pulmonary venous drainage into the coronary sinus or directly into the right auricle; (4) patent ductus arteriosus; (5) acquired mitral stenosis in older patients.

Five figures, including 2 roentgenograms; 1 table.

ROBERT H. LEAMING, M.D.  
Memorial Center, New York

#### Tomography of Calcified Aortic and Mitral Valves.

Paget Davies and N. L. Bucky. *Brit. Heart J.* **21**: 17-22, January 1959. (King's College Hospital, London, England)

With the advent of valvotomy, the detection of valvular calcification has become more important because its presence may affect the outlook for operative success. Sosman and Wosika described the fluoroscopic recognition of mitral and aortic valve calcification in 1933 (*Am. J. Roentgenol.* **30**: 328, 1933. *Abst. in Radiology* **23**: 382, 1934), and tomography was applied to the detection of valvular calcification in 1949 (Davies and Steiner. *Brit. Heart J.* **11**: 126, 1949. *Abst. in Radiology* **54**: 454, 1950). This paper deals with 20 cases of aortic valve calcification and 15 of mitral calcifications, and compares the value of fluoroscopy and tomography in their detection.

On fluoroscopy valvular calcifications have a dancing movement. The aortic valve is higher and more medial than the mitral. The lateral view shows the aortic valve anterior to the mitral, although this relationship can be altered by cardiomegaly. On the tomograph the shape of the calcification is the important feature. Aortic valve calcification shows as a channel or ring, while mitral calcification usually appears as an irregular star or band. Tomography has the further advantage of providing a permanent record.

In the entire group, calcification was demonstrated with certainty by tomography in 33 out of 35 patients, and probably in the other 2. Nineteen patients had aortic valve lesion, and fluoroscopy failed to show calcification in 2 of these. Of the 14 patients in whom mitral valve calcification was demonstrated by tomography, valvotomy was done in 11 and the diagnosis was confirmed. In 3 of these 11 cases fluoroscopy was unsuccessful in showing calcification.

Seven tomograms; 1 table. J. S. ARAJ, M.D.  
Toledo, Ohio

**A New Kymographic Sign of Myocardial Infarct: Dissociation of Kymographic Layers.** Ismet Sayman. *J. de radiol.* **40**: 46, January-February 1959. (In French) (Istanbul, Turkey)

Asynchronism or paradoxical pulsation has been described previously as a sign of myocardial infarct in



the roentgen kymogram. The author has observed a sign which he calls dissociation of the kymographic layers. This indicates that, on the same side of the kymographic tracing, one may see a kymographic layer demonstrating pulsations which are normal in number and amplitude and one or more adjacent layers showing diminished pulsations.

CHARLES M. NICE, JR., M.D., Ph.D.  
Tulane University

**Congenital Diverticula of the Pericardium.** Stanley C. Fell, Clarence J. Schein, Allan E. Bloomberg, and Berta M. Rubinstein. *Ann. Surg.* 149: 117-125, January 1959. (Montefiore Hospital, New York 67, N. Y.)

The authors summarize the data on 25 previously reported proved cases of congenital pericardial diverticula and add 4 more, bringing the total to 29. Fifteen of the diverticula were discovered at autopsy, 13 were excised *via* thoracotomy, and in 1 of the authors' cases diagnosis was established by thoracoscopy. The age of the patients ranged between twenty and sixty-two years. In 21 cases the diverticulum was located along the right cardiac border, 2 arose from the left side of the pericardium, 4 were anterior and 1 posterior; in 1 case the location was not mentioned.

The diagnosis of congenital pericardial diverticulum is suggested by a smoothly rounded or ovoid circumscribed mass, adjacent to a cardiac border and inseparable from the cardiac silhouette. The differential diagnosis includes loculated pericardial effusion; pericardiocoelemic cyst; cardiac chamber enlargement; aneurysm of the heart, ascending aorta, or sinuses of Valsalva; neoplasm of the pericardium, heart, or mediastinum; pericardial fat pad; Morgagni hernia.

Fluoroscopy and kymography show that pulsation is transmitted rather than expansile. Angiocardiography may be required to exclude aneurysm or chamber enlargement. Variation in the size and shape of the diverticula with respiration has been noted. On inspiration they appear long and narrow; with expiration they become short and broad; these findings are not constant, however, and similar changes have been found with other thin-walled intrathoracic cystic tumors. Inspiratory and expiratory roentgenograms were made in 3 of the authors' 4 cases, and variations in the size and shape of the pericardial diverticulum were found in 2.

Roentgenography with the patient in the lateral decubitus position with the side of the diverticulum elevated has been suggested. In this position, the mass might become smaller with emptying of the fluid into the pericardial sac. Brown and Thomas (*Am. J. Surg.* 72: 262, 1956. *Abst. in Radiology* 48: 654, 1957) utilized a modification of this method (diagnostic pneumopericardium with roentgenograms in Trendelenburg position) in 1 case. No diminution in size of the diverticulum could be visualized in 2 of the authors' cases in which the procedure was employed. Diverticular air insufflation under thoracoscopic control, with subsequent radiographic demonstration of pneumopericardium, is suggested as a diagnostic measure. If the diagnosis can be established, excision is usually not indicated.

Six roentgenograms; 2 photographs; 1 table.

**Constrictive Pericarditis.** T. M. D. Gimlette. *Brit. Heart J.* 21: 9-16, January 1959. (St. Thomas's Hospital, London, England)

Constrictive pericarditis can arise from a number of

different conditions, all producing an indistinguishable end-result. The commonest single cause is tuberculosis. The condition may be acute or chronic. The symptoms are those of pulmonary and systemic venous hypertension. Associated myocardial damage may exist.

The author analyzes his observations in 62 cases and describes the result of surgical treatment. Radiographic findings include cardiac enlargement, present in 22 of 58 cases, and pericardial calcification, demonstrated in 42 per cent of the series. The calcification is densest at the diaphragmatic surface.

One chart; 5 tables.

J. S. ARAJ, M.D.  
Toledo, Ohio

**Dynamics of the Orifices of the Venae Cavae Studied by Cineangiocardiology.** Frank L. Campeti, George H. Ramsey, Raymond Gramiak, and James S. Watson, Jr. *Circulation* 19: 55-64, January 1959. (G. H. R., 260 Crittenton Blvd., Rochester 20, N. Y.)

A cineangiocardiology study of the venae cavae and the right atrium was undertaken particularly to determine the degree of closure of the caval orifices in the cardiac cycle. It was found that in atrial systole there is only partial anatomical closure by means of myocardial contraction. In this phase of the cycle, however, pressure changes contribute to arrest of flow of the contrast medium. That complete closure does not take place is clearly demonstrated by occasional regurgitation of contrast medium from the superior vena cava into the inferior during atrial systole. The authors interpret this as a sort of safety valve mechanism to prevent overdistention of the atrium.

It was noted that the whole of the superior vena cava and the right atrium were increased in size in inspiration and decreased in expiration.

Twenty-eight roentgenograms; 2 graphs.

ZAC F. ENDRESS, M.D.  
Pontiac, Mich.

**Anomalous Left Coronary Artery Arising from the Pulmonary Artery.** William J. Kuzman, Anton S. Yuskis, and David B. Carmichael. *Am. Heart J.* 57: 36-48, January 1959. (A.S.Y., 233 A St., San Diego 1, Calif.)

Three cases of anomalous coronary artery arising from the pulmonary artery are reported. The diagnosis in all 3 was made antemortem on the basis of clinical symptoms, electrocardiography, and x-ray findings.

The first patient was a two-month-old infant who was asymptomatic except when feeding or on exertion, when he appeared to have colicky pain, became pale and sometimes cyanotic, and perspired. Limpness and exhaustion followed these episodes. Physical examination was essentially negative. Roentgenograms showed an enlarged heart, and there were electrocardiographic signs of an anterolateral myocardial infarct. The child expired after a severe episode of distress. The attending physician made the diagnosis of aberrant left coronary artery originating from the pulmonary artery, and this was confirmed at autopsy.

In the second case, with similar clinical episodes at the age of eight weeks, x-ray examination also showed cardiac enlargement. Electrocardiograms afforded evidence consistent with myocardial ischemic changes, which suggested the diagnosis. Autopsy confirmation was obtained.

Similar attacks were observed in the third case at the

age of the  
basis of  
absence  
child die  
Cardia  
studies c  
type and  
ically o  
enlargem  
cle, with  
ventricu  
on the l  
the left  
of obstru  
lobe. Th  
should b  
deaths i  
proved t  
Nine f

Supra  
William  
A. Boye  
M. L., F  
Direct  
aorta fro  
order to  
35 atten  
significa  
other tha  
In 16  
patients  
or the ot  
tation w  
cation.  
surgical  
nal man  
tion of f  
[One  
of the fil  
poorly  
Five

Angio  
Garland  
and Joh  
393, Sep  
more 5,  
The a  
White-C  
graphic  
roentgen  
given in  
postmon  
features  
The m  
left cor  
Roentge  
largemen  
of the le  
pulsatio  
to be de  
The a  
thinning

age of three weeks. The diagnosis was made on the basis of history, electrocardiographic findings, and absence of murmurs. Surgery was attempted, and the child died in the operating room.

Cardiac catheterization and angiocardiographic studies contribute little to the diagnosis of cases of this type and may very well be contraindicated. Radiologically one is impressed with the massive cardiac enlargement, involving predominantly the left ventricle, with true aneurysm on occasion. The degree of ventricular enlargement may be sufficient to encroach on the left main-stem bronchus or on that supplying the left lower lobe, thereby producing a ball-valve type of obstructive emphysema or frank collapse of an entire lobe. The diagnosis may be overlooked at autopsy, and should be kept in mind in all sudden, unexplained deaths in infancy. Surgery in these cases has so far proved unsuccessful.

Nine figures, including 3 roentgenograms.

ROGER M. STOLL, M.D.  
New York, N. Y.

#### Suprasternal Transaortic Coronary Arteriography.

William M. Lemmon, J. Stauffer Lehman, and Randal A. Boyer. *Circulation* 19: 47-54, January 1959. (W. M. L., Hahnemann Hospital, Philadelphia 2, Penna.)

Direct percutaneous needle puncture of the ascending aorta from the neck was carried out by the authors in order to opacify the coronaries and proximal aorta. Of 35 attempts, 31 were successful to some degree. No significant complications resulted from the procedure other than a small pneumothorax in one patient.

In 16 patients only one coronary artery was seen; in 5 patients neither one opacified. Poor visualization of one or the other occurred 8 times. Cases with aortic regurgitation were particularly prone to poor coronary opacification. In patients with good visualization in whom surgical procedures (coronary endarterectomy or internal mammary implantation) were done later, correlation of the x-ray and operative findings was good.

[One must take the authors' word for their evaluation of the films, since the reproductions are very small and poorly done.]

Five roentgenograms; 1 photograph.

ZAC F. ENDRESS, M.D.  
Pontiac, Mich.

**Angiocardiographic Features of the Bland-White-Garland Syndrome.** Erich K. Lang, Leon A. Phillips, and John G. McAfee. *Am. J. Roentgenol.* 80: 381-393, September 1958. (Johns Hopkins Hospital, Baltimore 5, Md.)

The authors report four proved cases of the Bland-White-Garland syndrome emphasizing its angiocardiographic features. The clinical, electrocardiographic, roentgenologic, and angiocardiographic findings are given in detail and compared with the surgical and postmortem findings. In addition, the diagnostic features of 62 cases from the literature are summarized.

The most common form of this anomaly involves the left coronary artery and presents clinically in infancy. Roentgenographically there is usually cardiac enlargement, particularly of the left ventricle. Atelectasis of the left lower lobe is also common. Fluoroscopically, pulsations along the left ventricular border are shown to be decreased or absent.

The angiocardiogram demonstrates a characteristic thinning of the myocardium near the apex and absence

of pulsations of the huge left ventricle. Displacement of the right ventricle and left atrium are frequently seen.

Thirteen roentgenograms; 1 table.

ROBERT H. LEAMING, M.D.  
Memorial Center, New York

**Transposition of the Pulmonary Veins.** Maria Fogel, Zsuzsa Somogyi, and János Gács. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 90: 32-37, January 1959. (In German) (Röntgeninstitut der III. Med. Universitätsklinik and der III. Chir. Universitätsklinik, Budapest, Hungary)

Transposition of the pulmonary veins is a condition in which oxygenated blood coming from the lungs returns to the right heart instead of going to the left atrium. The transposition may be either total or partial. In the total variety a right-to-left shunt is essential for survival so that the left heart and the peripheral circulation can be supplied with arterialized blood. This shunt usually occurs through an associated septal defect. Partial transposition affects only one lung, usually the right, either *in toto* or in part. The condition can be recognized even on ordinary roentgenograms of the chest when pulmonary veins are seen to converge toward the base instead of leading to the hilus.

A 20-year-old woman gave a history of hyperthyroidism and polyarthritis followed by cardiac manifestations thought to be due to a double mitral lesion. There were also loss of weight and appetite, irritability, exertional dyspnea, palpitation, chest pain, and temperature elevation.

Examination revealed diffuse thyroid enlargement, moist hands, and flattening of the right hemithorax. The lungs appeared normal, but there was a double murmur over the pulmonic area. Pulse rate and blood pressure were normal. The liver was slightly enlarged and tender.

Roentgenograms of the chest showed the right hilus to be decreased in size and density. Some of the adjacent vascular markings led downward in a curvilinear fashion alongside the bulging right heart border. As several branches converged, a large vessel was formed, with fusiform widening at the base posteromedially. Tomograms confirmed the presence of the abnormal vessel and of a small pulmonary artery and showed absence of the right middle lobe artery.

Angiocardiography disclosed filling of the left atrium simultaneously with the dextrocardiogram. When the left heart chambers were filled, the right heart remained opacified. The pulmonary veins filled simultaneously with the abnormal vessel, which was the only path of venous drainage on the right.

Bronchography revealed a steeply descending right main bronchus, abnormal branching of the right upper-lobe bronchus, and absence of the right middle-lobe bronchus. The branches of the right lower-lobe bronchus were sparse and thin. A cardiac catheter could be directed to the right atrium, inferior vena cava, and the pulmonary artery, but failed to reach the left heart chambers and the anomalous vein on the right side. Oxygen saturation was 67 per cent in the superior vena cava, 84 per cent in the right atrium, and 97 per cent in the pulmonary capillaries as well as in the femoral artery.

It was concluded that the patient had transposition of all pulmonary veins on the right side to the inferior vena cava, with developmental abnormalities of the

right bronchial tree, hypoplasia of the right pulmonary artery, absence of the right middle lobe, hypoplasia of the right lower lobe, and an atrial septal defect with right-to-left shunt.

Recognition of this developmental abnormality is especially important if thoracic surgery is contemplated. Pneumonectomy of the impaired anomalous lung can help correct the increased work load of the right heart, but is potentially hazardous because of the large vein leading downward to the inferior vena cava. The originally healthy contralateral lung must be preserved, if at all possible, because it furnishes the main supply of oxygen to the body.

Seven roentgenograms. ERNEST KRAFT, M.D.  
Northport, N. Y.

**A Fluoroscopic Sign of Pulmonic Stenosis.** Henry Green. J. M. Soc. New Jersey 56: 27-29, January 1959. (825 S. Tenth St., Newark, N. J.)

The fluoroscopic finding of asymmetric pulsation of the branches of the pulmonary artery is presented as a reliable sign, when present, of valvular pulmonic stenosis.

Thirty-six cases of valvular pulmonic stenosis without overriding of the aorta were gleaned from a larger group of patients with congenital heart disease seen from 1952 to 1956. The diagnosis was established in each instance by cardiac catheterization with the demonstration of a pressure gradient of abrupt occurrence between the main pulmonary artery and the right ventricle. In 7 patients, there was a distinctly observable expansile pulsation of the left pulmonary artery, while the right pulmonary artery shadow was remarkably quiet. The asymmetric hilar pulsation was always accompanied by an unduly prominent pulsation of the main pulmonary artery.

To determine whether this ratio (19 per cent) was constant or merely a reflection of the observer's awareness, a special search was made for this fluoroscopic sign in subsequent examinations of patients with congenital heart disease. It was found in 10 (67 per cent) of 15 consecutive cases of valvular pulmonic stenosis without overriding of the aorta established by means of cardiac catheterization from 1956 through March 1958. This is closer to the actual frequency of the finding and reflects increasing familiarity of the clinic staff with the fluoroscopic criterion.

The only other condition in which the author has observed an actively pulsing left hilus in the presence of a quiet right hilus is congenital absence of the right pulmonary artery. It might be expected, also, in a localized aneurysm of the left pulmonary artery.

**Occluding Dissecting Aneurysm as a Complication of Carotid Angiography.** Kjell Liverud. J. Oslo City Hosps. 8: 209-219, 1958. (Ullevål Hospital, Oslo, Norway)

Before 1953, 700 percutaneous carotid angiographies were performed at the Ullevål Hospital without mortality. In 1953, 3 fatalities occurred with symptoms of impaired cerebral blood flow during or shortly after the procedure, and death in eight hours to two and a half days. Postmortem examinations showed a dissecting aneurysm of the common carotid artery arising at the site of the needle puncture in each case.

This complication must be attributed to the technic itself rather than to any individual error in its application. Experiments on carotid artery specimens showed

that, when the needle is inserted into the wall, its layers may be dissected down to the aorta. It is suspected that some of the fatalities of carotid angiography described in the literature may be due to this cause.

In order to avoid a repetition of these accidents, the author has adopted a new technic in which the sharp needle in the vessel is replaced by a flexible polyethylene catheter introduced percutaneously (see following abstract).

Four roentgenograms with accompanying drawings; 2 groups of schematic drawings.

GARTH R. DREWRY, M.D.  
Tampa, Fla.

**Technique in Percutaneous Carotid and Vertebral Angiography with Polyethylene Catheters.** Kjell Liverud. J. Oslo City Hosps. 8: 220-242, 1958. (Ullevål Hospital, Oslo, Norway)

Because of fatalities during percutaneous carotid angiography with a needle (see preceding abstract), the author changed to the catheter method (see Seldinger: Acta radiol. 39: 368, 1953. Abst. in Radiology 62: 466, 1954) in 1954. This has since been used in about 1,000 cases without a fatality. A hollow needle is introduced into the common carotid artery. A wire stylet is passed through it and the needle is removed. A polyethylene catheter is then passed over the stylet into the artery and the stylet is withdrawn. The author describes the procedure in considerable detail and emphasizes the importance of correct technic. A few vertebral angiograms were successfully performed by the same method.

The advantages of the method are safe intraluminal injection, freer choice of projection, choice of external, internal, or common carotid angiography in the same investigation, easier diagnosis of carotid thrombosis, and better bilateral filling of the cerebral vessels during contralateral carotid compression. Injections may be carried out at longer intervals to reduce the action of the contrast medium on the cerebral vessels. Exposure of the investigator to x-rays can be diminished by lengthening the catheter or attaching it to an automatic pressure syringe.

Twelve roentgenograms; 1 photograph; 3 diagrams.

GARTH R. DREWRY, M.D.  
Tampa, Fla.

**Circulation Through the Posterior Communicating Artery in Different Compression Tests.** A Preliminary Report. Georg-Fredrik Saltzman. Acta radiol. 51: 10-16, January 1959. (Serafimerlasarettet, Stockholm, Sweden)

Compression of the vertebral artery between its origin in the subclavian and its entrance into the transverse foramen of the sixth cervical vertebra was accomplished by a finger introduced just above the clavicle and behind the common carotid artery. Visualization of the posterior communicating artery was accomplished in routine carotid cerebral angiographies in over half the cases when this technic of bilateral compression of vertebral arteries was employed.

This visualization of the posterior communicating artery may be of value in the localization of expanding lesions in this area and in tentorial herniations.

Twelve roentgenograms.

GEORGE L. SACKETT, M.D.  
Cleveland, Ohio

Percutaneous Mesenteric

25-32, Jan. 1959. By introduction of polyethylene catheter into femoral, superior mesenteric artery. The site of point of opposition space. Upright; the body weight second. S and abnormal. Seven r

Aneurysm Benedict 35-41, Jan. 1959. Fla.)

The aortic renal artery quency w their case analysis reported of the undence of f that, wh artery an saccular asympto ation sho pain, hem in pregn

Althoug with the calcific ri procedur calcificat fied lym hematom Nine r

Nephro Experiment G. Helander (Karolin

The n been stu catheteri 1 animal artery, into the as half a Since trast is r rographi contrast lesser ex the tubu Eight

**Percutaneous Selective Angiography of the Superior Mesenteric Artery.** Per Ödman. *Acta radiol.* 51: 25-32, January 1959. (Karolinska Sjukhuset, Stockholm, Sweden)

By introduction of a specially designed radiopaque polyethylene catheter into the abdominal aorta trans-femorally, the catheter tip can be made to enter the superior mesenteric artery under fluoroscopic guidance. The site of origin of the artery was found to vary from a point opposite the upper border of L2 to T12-L1 interspace. Urografin 45 per cent was used for arteriography; the dosage recommended is 0.8 to 0.9 ml./kg. body weight, and the rate of injection 8.0 to 9.0 ml. per second. Serial films in two planes were made. Normal and abnormal studies are illustrated.

Seven roentgenograms; 1 chart.

GEORGE L. SACKETT, M.D.  
Cleveland, Ohio

**Aneurysm of Renal Artery: Report of Five Cases.** Benedict R. Harrow and Jack A. Sloane. *J. Urol.* 81: 35-41, January 1959. (2621 Biscayne Blvd., Miami, Fla.)

The authors report 5 new cases of aneurysm of the renal artery, and call attention to the increasing frequency with which this diagnosis is being made. All of their cases were of the calcified saccular type. In an analysis of the literature it was found that all of the reported cases of ruptured renal artery aneurysms were of the uncalcified type, representing a 25 per cent incidence of rupture in that group. It is therefore believed that, while surgery is indicated for uncalcified renal artery aneurysms, it is not always indicated for calcified sacular aneurysms, irrespective of size, especially in asymptomatic, normotensive elderly individuals. Operation should be done, however, in cases associated with pain, hematuria, hypertension, or renal impairment, and in pregnant patients.

Although aortography is usually unnecessary in cases with the typical "cracked-eggshell" appearance of the calcific ring in the renal hilus, the authors feel that the procedure should be utilized in cases with atypical calcification to differentiate between aneurysms, calcified lymph nodes, cysts, neoplasms, old traumatic hematomas, and tuberculomas.

Nine roentgenograms. HORACE W. SCOTT, M.D.  
University of Pennsylvania

**Nephrographic Effect in Renal Angiography. An Experimental Study in Dogs.** N. P. G. Edling and C. G. Helander. *Acta radiol.* 51: 17-24, January 1959. (Karolinska Sjukhuset, Stockholm, Sweden)

The nephrographic effect in renal angiography has been studied experimentally in dogs. Transfemoral catheterization of each renal artery was first done. In 1 animal Miokon 50 per cent was injected into one renal artery, and Thorotrast was injected simultaneously into the opposite side. Serial films at intervals as brief as half a second were made.

Since Miokon is excreted by the kidneys and Thorotrast is not, this type of study indicated that the nephrographic effect is principally due to presence of the contrast material in the tubular cells and ducts and, to a lesser extent, filling of the veins by back diffusion from the tubular cells.

Eight roentgenograms.

GEORGE L. SACKETT, M.D.  
Cleveland, Ohio

**Skin Necrosis Complicating Femoral Arteriography.** D. S. Botseas and G. H. Lawrence. *Ann. Surg.* 149: 135-139, January 1959. (Virginia Mason Hospital, Seattle, Wash.)

Two cases of skin necrosis of the medial aspect of the thigh are described, both following retrograde injection of Urokon through catheters inserted into the superficial femoral arteries. Both patients had extensive atherosclerosis and apparently [though this is not stated definitely] the procedure was done under local anesthesia.

The authors believe that the lesions were probably caused by local vessel damage by a large bolus of contrast medium reaching smaller vessels (already involved by atherosclerosis) in high concentration. Drug sensitivity could not be completely ruled out but seemed unlikely. Nevertheless the authors switched to Hypaque and general anesthesia and encountered no more instances of necrosis in 20 further cases.

Two other cases of skin necrosis following arteriography were found in the literature (Wagner: *J.A.M.A.* 125: 958, 1944. *Abst. in Radiology* 45: 99, 1944; McAfee: *Radiology* 68: 825, 1957).

Three photographs. ZAC F. ENDRESS, M.D.  
Pontiac, Mich.

**Clinical Manifestations of Primary Varicose Veins. I. An Evaluation of Some Phlebographic Findings in the Deep Veins.** Frits R. Mathiesen. *Acta chir. scandinav.* 116: 155-162, 1959. (Rigshospitalet, Copenhagen, Denmark)

The deep veins of the lower leg were studied phlebographically by the tilting technic in 275 patients with primary varicose veins and in 27 normal lower limbs. In the interpretation of the phlebograms, the series was analyzed according to the following criteria: (1) spindle-shaped dilatation of the veins of the lower leg (121 cases); (2) filling of the larger muscular veins (120 cases); (3) filling of fine muscular collaterals (96 cases); (4) functional capacity of the deep veins of lower leg (good, 256 cases; moderate, 12; poor, 7). These findings were related to those observed in a series of normal subjects, to previous treatment, and to the discomfort experienced by the patients.

Patients with recurrent varicose veins after previous operation showed greater incompetence of the valves of the deep veins, whereas venous dilatation seemed to be without importance in the development of varicose veins or accompanying discomfort. Filling of the large muscular veins was observed with about the same frequency in normal subjects and in those with varicose veins. In the latter group, it may be related to an increased tendency to discomfort; it seems to occur slightly more frequently in patients with recurrent varicose veins after previous treatment, but the study did not permit definite conclusions on this point.

Fine muscular collaterals occurred almost exclusively in patients with varicose veins, in particular in those who had previously been treated by operation or injection. Symptoms seemed to be more frequent and of a more severe character in patients in whom phlebography revealed filling of these fine collaterals.

From this investigation, it cannot be stated whether the frequent occurrence of fine muscular collaterals is evidence of selection because of a special tendency to discomfort in these patients or a sign of venous damage referable to previous operation (or ensuing complications).

Three phlebograms; 4 tables.



## THE DIGESTIVE SYSTEM

**Simultaneous Fluorocinematography and Intraluminal Pressure Measurements in the Study of Esophageal Motility.** Gaston Vantrappen, Martin D. Liemer, Junko Ikeya, E. Clinton Texter, Jr., and Clifford J. Barborka. *Gastroenterology* 35: 592-602, December 1958. (E. C. T., Northwestern University Medical School, Chicago 11, Ill.)

A method is described for studying esophageal motility, based on the principle of simultaneous filming of intraluminal pressure tracings and amplified fluoroscopic images. This technic permits correlation of pressure changes and radiologic phenomena, thus facilitating the study of the nature and function of the various pressure waves. The present communication is based on 32 studies in normal subjects and patients with peptic ulcer, esophageal disorders manifested by dysphagia, pain, or heartburn, hiatal hernia, varices, and functional esophageal disturbances.

Correlations were made between the different parts of the normal swallowing complex and radiologic phenomena. Observations on the "high-pressure zone" in normal subjects and patients with hiatal hernia confirm the presence of a physiologic sphincter at the gastroesophageal junction. One of the functions of the diaphragm in the closing mechanism at the gastroesophageal junction is that it permits the infradiaphragmatic segment of the high-pressure zone to escape the influence of the negative inspiratory intrathoracic pressure. By so doing, the diaphragm helps to keep the pressure in the infradiaphragmatic segment above the pressure of the fundus of the stomach.

Observations on patients with "tertiary contractions" of the esophagus indicate that the various radiologic appearances that may be observed ("curling," "corkscrew," "pseudodiverticula," etc.) are all manifestations of the same basic phenomenon, namely, of nonperistaltic activity of the esophagus. Some of the characteristics of this nonperistaltic activity are described. Nonperistaltic waves may vary from nonrepetitive waves in the lower esophagus to repetitive waves involving a larger segment of the esophagus. There may be complete absence of peristalsis in the entire segment with frequent repetitive waves, elevations of the resting esophageal pressure, and abnormalities of the high pressure zone. The transitional form between the several extremes suggests a single process with varying grades of severity.

This entire article is recommended to those who have a special interest in the esophagus and its radiologic problems.

Six tables.

ALFRED O. MILLER, M.D.  
Louisville, Ky.

**Acquired Esophagotracheal Fistula Secondary to a Foreign Body in the Esophagus.** Yosh Maruyama, John R. Pettet, and Charles R. Green. *New England J. Med.* 260: 126-127, Jan. 15, 1959. (Tokyo United States Army Hospital, Tokyo, Japan)

An esophagotracheal fistula resulting from a swallowed denture is reported. A 19-year old soldier had an epileptic attack three months before admission, after which he was unable to find his denture. During this interval he experienced progressive difficulty in swallowing, and for a week before admission he had paroxysms of severe coughing each time he swallowed. Roentgenograms of the chest obtained once before admission

and on admission were considered unremarkable. Barium swallow revealed a dilatation of the proximal third of the esophagus and the right bronchial tree was partially demonstrated. Spot films disclosed fistulous opening between the esophagus and trachea with two small, metallic, hook-shaped densities adjacent to the tract. Thoracotomy permitted removal of a 4 X 4-cm. plastic denture and the patient recovered.

The materials now used in dentures are often radiolucent and their roentgen detection depends on minute metallic parts. A barium swallow examination may be useful, and in questionable cases a cotton pledget soaked in thick barium can give additional help in localizing a small foreign body.

Two roentgenograms; 1 photograph.

MORTIMER R. CAMIEL, M.D.  
Brooklyn, N. Y.

**Chronic Antral Gastritis as a Precancerous Condition.** S. N. Popov and Z. Ya. Karmanova. *Vestnik Rentgenol. i Radiol.* 34: 23-29, January-February 1959. (In Russian) (Tambov, Russia)

The authors present 24 cases of chronic antral gastritis. Thirteen of the patients were operated on and histologic examination revealed elements of malignant growth in 4. Of the remaining 11 patients, 3 eventually died of cancer of the stomach. Because the deformed mucosa in gastritis can easily conceal a small tumor in its initial stages, follow-up examinations or histologic studies are indicated in this condition.

B. ABRAMSON, M.D., and F. RIEBEL, M.D.  
Columbus, Ohio

**Clinical Diagnosis in Gastrointestinal Hemorrhage. A Planned Investigation Including Arteriographic Studies of the Human Stomach.** John K. Wagstaff. *Gastroenterology* 36: 26-44, January 1959. (Brighton General Hospital, Brighton, England)

A detailed analysis of 250 cases of hematemesis or melena is reported, with particular attention to the symptoms and clinical findings. Among the presumptive causes of bleeding in this series were gastric and duodenal ulcer, gastric cancer, atrophic gastritis, hepatic cirrhosis, hiatal hernia, blood diseases, and portal hypertension of neoplastic origin. In the course of the study arteriograms were obtained of 27 normal stomachs removed from cadavers. These showed that in both the seromuscular and submucosal layers, the arteries that are large enough to cause severe hemorrhage are confined for the most part to the upper two thirds of the stomach. Those of the submucosa are further limited to a band on either side of the lesser curvature. This, therefore, was the only likely source of severe hemorrhage from a shallow ulcer, which is usually missed on x-ray studies.

From his analysis, the author assesses the value of symptoms and signs for determining the causal lesion of hemorrhage from the upper gastrointestinal tract. The following findings were more common in gastric than in duodenal ulcers: (1) pain within half an hour after eating, (2) anorexia, (3) empty feeling between meals, (4) blood clots in vomitus, (5) chronic bronchitis. The following were more common in duodenal ulcers: (1) nocturnal pain or discomfort, (2) periodic pain or discomfort, (3) pain in the right upper quadrant, (4) copious vomiting, (5) coffee-ground vomitus, (6) tenderness in the right upper quadrant.

When these criteria were applied in a further 100



cases of upper gastrointestinal hemorrhage, a correct diagnosis was made, on admission, in 21 of 31 patients who proved to have gastric ulcer. In only 1 case was the ulcer thought to be in the duodenum, and this patient had duodenal diverticula. Fourteen of the 19 proved duodenal ulcers were diagnosed correctly on admission. The author concludes that bleeding duodenal ulcer can be clinically diagnosed with great accuracy.

Three arteriograms; 1 diagram; 10 tables.

J. S. ARAJ, M.D.

Toledo, Ohio

**Benign Lesions of the Pyloric Antrum Simulating Carcinoma.** J. N. Pattinson and G. Osborne. With Comments on the Value of Gastroscopy in the Diagnosis of Antral Lesions. Norman C. Tanner. *Brit. J. Radiol.* 32: 1-6, January 1959. (Middlesex Hospital, London, W. 1, England)

Deformities of the pyloric antrum seen at radiographic examination frequently pose the problem as to whether they are malignant or benign. Seven cases originally believed to be malignant because of concentric narrowing and lack of peristalsis in the prepyloric area are here reported. Surgery later proved these deformities to be secondary to benign conditions. Six patients were fifty-six years old or over.

In 3 patients the changes were found to be due to fibrosis associated with a low lesser curve gastric ulcer; in 2 to pyloric hypertrophy (with a duodenal ulcer in one case and a benign duodenal tumor in the other); in 1 to spasm or edema. In the remaining patient the antrum was adherent to the gallbladder and there was evidence of a healed prepyloric ulcer.

In a review of the cases after establishment of the correct diagnosis, it was found that in each instance the edge of the antral deformity was quite smooth, without any "half-shadow" effect, and there was no "shouldering" or intra-luminal filling defect, whereas all the antral carcinomas seen during the period under review showed one or more of these signs.

Even if a benign lesion is suspected, one must consider the possibility of malignancy. It must also be remembered that infrequently two or more lesions are found in the stomach. A benign ulcer may occur along with an antral carcinoma. It is unsafe to assume that an antral deformity may be due to spasm or hypertrophy secondary to a benign ulcer higher in the stomach.

The role of gastroscopy is discussed. It is felt that this is particularly useful in two groups of patients: (1) those with a history of bleeding but with negative x-ray findings; (2) those with radiological lesions which may or may not be cancer. Many ulcers may appear benign at radiological examination but are obviously malignant at gastroscopy. There are, however, a small number of ulcers that cannot be immediately differentiated at gastroscopy. For these, repeat gastroscopy in two to three weeks after bed rest and regular meals is indicated.

In conclusion, it is emphasized that any antral deformity should give rise to a suspicion of malignancy. Re-examination with an antispasmodic should be done to establish constancy of the deformity. If the issue remains unresolved, then gastroscopy should be undertaken.

Eleven roentgenograms.

EARL R. BROWN, JR., M.D.

Indiana University Medical Center

**Development of Primary Pyloric Hypertrophy in Adults in Relation to the Structure and Function of the Pyloric Canal.** Stanley C. Skoryna, H. S. Dolan, and A. Gley. *Surg., Gynec. & Obst.* 108: 83-92, January 1959. (St. Mary's Memorial Hospital, Montreal, Que., Canada)

The authors review the anatomy and physiology of the pyloric canal and suggest that the mechanism for primary pyloric hypertrophy is a congenital neuromuscular dysfunction of the pyloric canal mechanism. This forms a common basis for both infantile and adult hypertrophy; the relative incidence appears to be determined by the extent of the normal regression of the circular musculature of the pyloric canal during early infancy and by the action of secondary factors during adult life.

Pyloric hypertrophy in adults is classified as primary and secondary, as follows:

#### I. Primary pyloric hypertrophy

1. Focal form
2. Diffuse form associated with proximal (gastric) lesions
3. Diffuse form without proximal (gastric) lesions

#### II. Secondary pyloric hypertrophy

1. Associated with distal obstructive lesions

Six proved cases are presented and discussed.

Symptoms of primary pyloric hypertrophy are generally vague but are usually somewhat ulcer-like in character. The diagnosis can usually be made roentgenologically. No specific radiologic pattern is found, but generally there is elongation of the pyloric canal and considerable decrease in the flexibility of the wall of the pyloric canal. The contour of the canal itself is usually smooth and there may be a concave impression of the hypertrophic muscle on the base of the duodenal cap and/or the antral end of the pyloric canal.

The treatment of choice is limited gastric resection with gastroduodenal or gastrojejunal anastomosis.

Three roentgenograms; 3 photographs; 1 diagram.

WALLACE T. MILLER, M.D.

University of Pennsylvania

**Duodenal Megabulbus and Annular Pancreas.** E. E. T. Taylor. *Brit. J. Surg.* 46: 392-396, January 1959. (Northampton, England)

Obstruction of the duodenum with secondary gross dilatation of the bulb is described in 4 patients. Kinking of the second portion of the duodenum associated with the sagging of visceroptosis produced the obstruction in 2 cases. In each of the others, the duodenum was kinked as it sagged over the anterior loop of an annular pancreas. In none was actual constriction or an intrinsic occluding lesion present. A fifth patient is briefly mentioned whose upper descending duodenum was partially obstructed by a cholecysto-gastro-colic band.

This condition, referred to as "duodenal megabulbus," is to be differentiated from the duodenal occlusion associated with visceroptosis in the mesenteric artery syndrome and from those cases of annular pancreas in which there is actual compression of the duodenal lumen by a narrow annulus.

Fluoroscopy and roentgenograms characteristically show a very large duodenal bulb, a widely patent pylorus, and a large, but not decompensated, stomach.

The author points out that annular pancreas may produce obstruction many years after birth as a result of duodenal kinking, and that simple division of the

pancreatic ring may not relieve the symptoms if that is the cause. Duodenojejunostomy is believed to be the preferable method for surgical management.

Seven roentgenograms; 2 photographs.

DON E. MATTHIESEN, M.D.  
Phoenix, Ariz.

**Intestinal Hypertrophy Following Partial Resection of the Small Bowel in the Rat.** C. C. Booth, K. T. Evans, T. Menzies, and D. F. Street. *Brit. J. Surg.* 46: 403-410, January 1959. (Postgraduate Medical School of London, London, England)

During intestinal absorption studies the authors found that in rats enlargement of the distal small bowel frequently developed after operations on the upper intestine. Further investigation was felt to be indicated and is reported in this article. One-third or two-thirds of the small bowel was resected in 25 rats; in 11 others simple division and reanastomosis were performed. Radiographic studies were then carried out three to twenty-four weeks after surgery.

The small-bowel pattern in the rat is ribbon-like unlike the feathery pattern seen in man. Small-bowel transit time averages ninety minutes. Resection of one-third or two-thirds of the proximal small intestine produced no significant change in transit time; but distal to the anastomosis moderate to marked enlargement of the intestine was noted. When the resections were of the distal small bowel, no hypertrophy developed, but transit became much more rapid. Following simple division and resuture, the pattern and physiology of the small bowel were not changed.

Histologic appearances indicate that when enlargement of the small bowel occurs, it is due to true thickening of both the muscular and the mucosal layers. This is evidently a compensatory change, enabling the bowel to accommodate the larger volume reaching the distal portion when the proximal portion (which usually absorbs much of the food) has been removed.

Three roentgenograms with accompanying autopsy specimens; 3 photomicrographs; 6 tables.

DON E. MATTHIESEN, M.D.  
Phoenix, Ariz.

**Radiologic Considerations in Diagnosis and Treatment of Intussusception.** Edward B. Singleton. *Texas State J. Med.* 55: 27-33, January 1959. (Texas Children's Hospital, Houston, Texas)

Of the many abnormalities affecting the intestinal tract in children, ileocolic intussusception is of unique interest to the radiologist because it offers him the opportunity of both diagnosis and immediate treatment. The author's purpose in this paper is to consider the indications for and against hydrostatic reduction (by barium enema) and to present the criteria used at the Texas Children's Hospital (Houston) for determining whether this method should be attempted.

The arguments for and against the use of hydrostatic pressure are briefly discussed. If the child is three years of age or older, reduction by enema is not attempted. After this age it is probable that a definite lesion is responsible for the intussusception and, although these lesions are usually benign, they may be a source of future difficulty. Also, an occasional lymphosarcoma may be missed without surgical intervention.

In all cases of intussusception, scout roentgenograms of the abdomen with the patient in the supine and upright positions are obtained preceding fluoroscopy. If

the distribution and amount of intestinal gas are not unusual, the invagination is in an early stage and is usually reduced by hydrostatic pressure. If there is marked distention of small bowel associated with absence or nearly complete absence of gas within the colon, there is obviously a high degree of obstruction; reduction by hydrostatic pressure is less likely in these cases but may be attempted. The presence of obvious fluid content within the abdomen associated with marked distention of small intestine is presumptive evidence that bowel perforation and peritonitis have occurred, and not even an enema study for diagnostic purposes is undertaken.

Several types of intussusception are mentioned specially. The reduction of the colonic component of an ileo-ileocolic intussusception may be accomplished by hydrostatic pressure, but the ileal component persists. No attempt is made at the Texas Children's Hospital to reduce an ileoileal intussusception by hydrostatic pressure because of the barrier produced by the ileocecal valve and the frequency of devitalized bowel in this condition. Abrupt disappearance of the intussusception during fluoroscopy without gradual displacement of the intussusceptum into the region of the ileocecal valve suggests a colocolic intussusception. In cecocolic intussusception, the ileum is filled before the cecum is distended. This may be impossible to differentiate from an inverted appendiceal stump. Appendiceal intussusception is particularly difficult to diagnose radiologically. An illustrative case of this last variety is reported.

Details of the fluoroscopic technic are included.

Thirteen roentgenograms; 1 diagram.

**Acute Obstruction of Small Intestine Secondary to Hematoma in Children.** A. L. Mestel, G. A. Trusler, S. A. Thomson, and C. A. F. Moes. *Arch. Surg.* 78: 25-32, January 1959. (A. L. M., 250 E. 58th St., Brooklyn, N. Y.)

The authors review 13 previously reported cases of duodenal and jejunal hematoma in children and add 2 new cases in patients of eight and nine years. The condition almost invariably follows trauma and the outstanding clinical manifestations are upper abdominal pain and vomiting. A palpable mass may or may not be present. In 1 of the authors' cases, a mass extending along the duodenum and producing medial displacement of the angle of Treitz with obstruction at this level was observed on roentgenograms made after ingestion of a barium meal. The coil-spring sign described by Felson and Levin (*Radiology* 63: 823, 1954) was not apparent.

If the diagnosis is made, the treatment of choice is conservative, namely, gastric suction and intravenous fluid administration. If surgery is performed because of misdiagnosis or as an elective measure, simple evacuation of the hematoma is preferred to resection.

Five roentgenograms; 1 photograph; 1 table.

ANTONIO SIMAO, M.D.  
Cleveland Metropolitan General Hospital

**Lymphosarcoma of the Small Intestine in Infancy and Childhood.** A. L. Mestel. *Ann. Surg.* 149: 87-94, January 1959. (Beth El Hospital, Brooklyn, N. Y.)

The author was able to collect from two institutions (Hospital for Sick Children, Toronto, Canada, and Beth El Hospital, Brooklyn, N. Y.) 13 cases of lymphosarcoma of the small intestine in children from four

months to thirteen years of age. All appeared to be primary in the intestine at the time of diagnosis. Only 2 of the patients were alive at the time of the report (for three and a half and eight years); the others died of generalized disease in an average of 3.7 months.

There is no specific x-ray pattern which will give an unequivocal diagnosis of intestinal lymphosarcoma. The picture may be that of small bowel obstruction, the most common complication leading to surgery (and recognition). If intussusception has occurred, a barium enema will demonstrate the typical findings. Colicky pain with or without vomiting and often a palpable mass constitute the clinical picture.

Treatment consists of resection if possible, with post-operative irradiation.

Three tables.

ZAC F. ENDRESS, M.D.  
Pontiac, Mich.

**Colon Preparation for Radiological Studies Using a New Drug.** John A. Martin. *Virginia M. Month.* 86: 25-26, January 1959. (Roanoke Memorial Hospital, Roanoke, Va.)

Dulcolax, a new drug for colon preparation in radiological studies, is described and the routine of its use outlined. In Germany where the drug originated, satisfactory evacuation has been reported to occur in ten to forty minutes after its administration as a rectal suppository, with almost uniformly satisfactory results.

Dulcolax, bis (p-acetoxypheyl)-2 pyridylmethane, is a crystalline compound, colorless, tasteless, and insoluble in water and alkali. It is one of a family of new laxatives that exert their effect by contact with the intestinal mucosa rather than by absorption into the blood stream or irritation with hydrostatic action.

The results of colon preparation with this drug in about 70 of the author's patients were carefully observed. In many cases results were better than is usual with the castor oil routine and in all but 3 were satisfactory. There is some evidence—too scanty to permit conclusions—that failure of Dulcolax to produce catharsis has been due to a counter action by some other drug the patient is currently receiving, such as an opiate.

As a result of these studies, Dulcolax has replaced castor oil in routine preparation for colonic studies at the Roanoke Memorial Hospital, from which this report comes. The solid intake is restricted the day preceding the examination, the afternoon and evening meals being limited to clear liquids that will leave no residue; at 3:00 P.M. two Dulcolax tablets, or 10 mg., are given orally, and at 7:00 the following morning a 10-mg. rectal suppository is used.

**Hypaque Sodium Powder. A New Gastrointestinal Opaque.** Wm. E. Allen, Jr. *Missouri Med.* 55: 1308-1312, December 1958. (2601 N. Whittier St., St. Louis, Mo.)

Hypaque sodium powder is a non-toxic, water-soluble contrast material which has been found valuable in most instances in which barium sulfate can be used and frequently when the use of barium sulfate suspension is inadvisable or contraindicated, as in the presence of a perforated hollow viscus or a leaking intestinal anastomosis, for fistula and sinus tract injection, and for localization of foreign bodies in the gastrointestinal tract.

The author used Hypaque sodium powder in 15 routine upper gastrointestinal tract and 10 lower gastrointestinal tract studies and in 62 special examinations

of various types. Concentrations of 50 per cent caused diarrhea, but a 25 per cent solution (200 c.c.) was adequate for colon examination. The material was especially useful in differential diagnosis of paralytic and mechanical ileus, more particularly in postoperative cases. In the absence of organic obstruction, ingested Hypaque solution was seen at the cecum at two to three hours.

Hypaque was considered superior to barium for gastric mucosal relief studies. It was less satisfactory than barium for small bowel mucosal relief studies. It was also less satisfactory for small bowel mucosal detail, study of the pharynx and esophagus, and for double-contrast colon enema studies. The medium is not irritating to the peritoneum and is absorbed slowly from the peritoneal cavity. Six illustrative cases are reported.

Ten roentgenograms; 1 table.

GARTH R. DREWRY, M.D.  
Tampa, Fla.

**Serial Cholecystography. A Means of Preoperative Diagnosis of Biliary Dyskinesia.** J. Dudfield Rose. *Arch. Surg.* 78: 56-66, January 1959. (35 Eslington Terrace, Newcastle upon Tyne 2, England)

Serial cholecystography is presented as an accurate method of preoperative diagnosis for patients suffering from biliary dyskinesia. After defining this clinical entity and pointing out its frequent association with other biliary diseases, the author describes the technique of serial cholecystography, the physiological changes during the test, abnormal radiological aspects, and the preoperative diagnostic conclusions.

The patient is given a single dose of Telepaque (0.5 gm.) the night before the examination. If the first films, obtained fourteen hours later, fail to show the gall-bladder clearly or if gallstones are demonstrated, there is no need to proceed further. If the gallbladder is visualized and free of stones, 100 c.c. of ice-cold isotonic saline solution and a standard fatty meal are administered. Serial cholecystograms are then taken at ten-minute intervals up to eighty minutes. Both antero-posterior and lateral projections are obtained for the initial and serial cholecystograms. In order to minimize patient exposure, the forty-, fifty-, sixty-, and seventy-minute films can be omitted without significant reduction of the diagnostic accuracy of the examination.

The volume of the gall-bladder and its changes throughout the examination are estimated according to the method of Toulet (see Albot, Toulet, and Bonnet: *Arch. mal. app. digest.* 40: 1187, 1951). The angle between the long axis of the gallbladder and the long axis of the spine (angle of erection) is measured on the lateral view. From the initial measurements of the volume and angle of erection and their changes on successive cholecystograms, curves of evacuation rate and erection are drawn and compared with normal patterns. The study of these curves permits a bifurcate classification scheme of the functional disorders of the gall-bladder, although it must be regarded as tentative and used with some degree of elasticity. Visualization of the cystic and common ducts, its duration and time of occurrence, is a third factor to be taken into consideration for the diagnosis. The etiological factors of the several types of cholelithiasis are indicated on an abridged diagnostic scheme. The cholecystographic diagnosis is confirmed by peroperative manometric evaluation of the biliary tract.

The author reports six clinical cases illustrative of different types of biliary dyskinesia. An analysis of 100 cases studied both by this method and by classical cholecystograms demonstrates that of 66 cases having normal classical cholecystographic findings only 9 were shown to be normal, both functionally and morphologically, on the serial films, and in 56 there was biliary dyskinesia.

Serial cholecystography is believed by the author to be the only accurate examination permitting the pre-operative diagnosis of biliary dyskinesia. It should be carried out in any patient with biliary tract disorder in the absence of pathological findings on the classical cholecystographic study.

Eleven figures, including 2 serial cholecystograms; 2 tables.

ANTONIO SIMAO, M.D.  
Cleveland Metropolitan General Hospital

**Diagnostic Value of Intravenous Cholangiography During Acute Cholecystitis and Acute Pancreatitis.** Henry C. Johnson, Jr., B. Donald Minor, Jack A. Thompson, and H. Stephen Weens. *New England J. Med.* 260: 158-161, Jan. 22, 1959. (Emory University School of Medicine, Atlanta, Ga.)

The differentiation between acute pancreatitis and acute cholecystitis is an urgent clinical problem, since surgery is contraindicated in acute pancreatitis. During the past three years at Grady Memorial Hospital (Atlanta, Ga.) intravenous cholangiography was performed as an emergency procedure on 61 unselected patients who were thought to have either disease, in an attempt to determine whether the procedure was useful in differentiating between them.

The theoretical basis for the radiologic differentiation lies in the commonly accepted pathogenesis of acute cholecystitis—obstruction of the cystic duct. On the basis of this premise, it should be impossible to opacify the gallbladder in the presence of acute cholecystitis, but there would be no such mechanical block in the presence of pancreatitis. The authors' experience with the 61 cases bore out this premise and several important differential characteristics were obtained.

Of the 61 cases, 23 proved to be acute pancreatitis and 38 acute cholecystitis. No case of acute cholecystitis showed visualization of the gallbladder, while in approximately two-thirds of the pancreatitis cases (15 cases, 65 per cent) the gallbladder was opacified. When the gallbladder was visualized, the authors reliably excluded acute cholecystitis as a diagnostic possibility.

With acute cholecystitis the duct system was seen in about half the cases (18 cases, 47 per cent) but the gallbladder was never visualized. In acute pancreatitis visualization of the duct was always accompanied by visualization of the gallbladder. In other words, if the duct only was seen, the patient had cholecystitis; if the duct and gallbladder were seen, the patient had acute pancreatitis.

Failure of any opacification, either in the ducts or gallbladder, occurred in about a third of the pancreatitis cases (8 cases, 35 per cent) and half of the acute cholecystitis cases (20 cases, 53 per cent). There was thus no specific differential significance placed on the finding of total non-visualization.

For cholangiography the authors now inject intravenously 20 ml. of 52 per cent iodipamide methylglucamine. There were some minor, but no serious reactions. Roentgenograms were made routinely before the injection and ten, twenty, thirty, sixty, and one-

hundred twenty minutes after. If by two hours there was only faint or equivocal opacification, a four-hour interval film is also taken. An occasional patient with acute pancreatitis showing no visualization during this period, will show gallbladder opacification at the twelve- or twenty-four-hour interval.

One figure; 1 table. MORTIMER R. CAMIEL, M.D.  
Brooklyn, N. Y.

**Opacifying Gallstones.** Emanuel Salzman, Robert P. Spurck, Lawrence C. Kier, and David H. Watkins. *J.A.M.A.* 169: 334-338, Jan. 24, 1959. (West Sixth Ave. and Cherokee St., Denver 4, Colo.)

By "opacifying gallstones" the authors mean certain gallstones which become radiographically opaque after prolonged administration of cholecystographic contrast media, with or without the visualization of the gallbladder and biliary ducts (see Salzman and Warden: *Radiology* 71: 85, 1958). The test is especially applicable for demonstration of bile duct calculi in jaundiced patients, where even intravenous cholangiograms usually fail to help.

In the series reported here, 3 gm. of Telepaque (iopanoic acid) was given for four days in doses of 1 gm. after each meal, while the patient was on a fat-free diet. The test was well tolerated. Diarrhea was controlled with paregoric. On the fifth day the x-ray examination was done. Opacification of the gallbladder at this time is usually faint but the ducts are not visualized.

One hundred and twenty-three patients on whom earlier examinations had shown no concentration or poor concentration were examined by this technic. Of these, 76 had proved calculi. Of the 13 cases with proved bile-duct stones, 10 had opacifying stones; 4 of these also had opacifying stones in the gallbladder. In 3 cases opacification was not obtained, either because of severe jaundice or because the stones were of the non-opacifying type. Cholangiograms with Cholografin were obtained at the time of the four-day iopanoic acid test in 3 of the 10 patients with opacifying bile-duct stones. The ducts could not be visualized in 2 of these 3.

*In vitro* studies of 100 samples of stones demonstrated that pure pigmented calculi will become opacified, whereas pure cholesterol stones will not. Infectious calculi with pigmented surfaces will opacify, as will stasis calculi, which have a pigmented periphery. The authors suggest that biliverdin in the pigment combines with the opaque medium, resulting in opacification.

Nine roentgenograms; 2 photographs.

PAUL MASSIE, M.D.  
Quincy, Mass.

**Congenital Choledochal Cyst. Demonstration by Oral Cholecystography.** LaMar J. Hankamp. *J. Dis. Child.* 97: 97-100, January 1959. (St. Joseph Mercy Hospital, Ann Arbor, Mich.)

The author reports a case of congenital choledochal cyst demonstrated by means of oral cholecystography.

The patient was a 13-year-old Negro boy admitted with a six-day history of colicky epigastric and periumbilical pain. The urine was described as "dark yellow." Enemas had revealed "gray" stools. The patient had experienced similar attacks since the age of five years, when his first bout of visible jaundice had occurred.

A film of the abdomen was negative. Oral cholecystography produced faint opacification of a large round structure in the right upper quadrant of the abdomen.



The gallbladder could not be identified. A repeat oral cholecystogram with the same amount of Telepaque showed opacification of two structures in the right upper quadrant. The most lateral of these was tubular in shape and contracted well following a fatty meal. The cystic duct could be identified at its proximal end. The medial opaque image was roughly ovoid in shape, and showed no contraction after the fatty meal. The tubular structure could not be identified on a film taken four hours later, but there was very faint visualization of the larger ovoid structure. On the basis of this study, the possibility of a choledochal cyst was postulated.

At laparotomy the gallbladder was found to be long and slender. The cystic duct merged into a convoluted, somewhat flabby cyst-like cavity which held at least 3 ounces of fluid when distended. This cyst lay between the lower surface of the liver and the posterolateral aspect of the first and second portions of the duodenum. Probe patency between the cystic duct and the cyst was established. The cyst was anastomosed directly to the second portion of the duodenum.

Congenital choledochal cysts are to be differentiated from hydatid cyst, pancreatic cyst, congenital cysts of the liver, hydrops of the gallbladder, mesenteric cyst, retroperitoneal tumors, and intestinal duplication.

Six roentgenograms. THEODORE E. KEATS, M.D.  
University of Missouri

### THE MUSCULOSKELETAL SYSTEM

**Bone Infarction.** N. L. Bucky. *Brit. J. Radiol.* 32: 22-27, January 1959. (Prince of Wales's Hospital, London, N. 15, England)

Eight cases of bone infarction are presented along with a review of the theories of the pathogenesis of bone infarcts. Aseptic bone infarction occurs most frequently in persons working in compressed air, but similar lesions have been encountered in patients never subjected to this type of occupation hazard.

In accordance with Henry's law, the amount of atmospheric gases taken into solution by the blood in the lungs increases with a rise in their pressures. Transfer of the gases from blood to tissues occurs gradually. Fat has a special affinity for nitrogen and dissolves over five times more than water-containing tissues. On rapid decompression, the gases are set free *in situ*. The large volume of nitrogen liberated in fatty tissues produces decompression sickness with joint pain due to distention and distortion of periarticular tissues by gas. With slow decompression, the gas is gradually eliminated *via* the lungs.

The cause and development of bone infarcts are not yet clear. The majority occur in the femur, humerus, and tibia, bones which contain practically all the fatty bone marrow.

The production of bone infarcts in decompression is related to the release of nitrogen from the fatty marrow, thus increasing the pressure within the marrow cavity. The fatty marrow has a poor blood supply and the vessels are particularly vulnerable to compression and distortion. Infarcts most frequently occur in the area supplied by the nutrient artery. Vascular spasm and some element of thrombosis also contribute to the ischemic condition and production of infarcts.

There is less evidence as to the cause of infarcts in persons never subjected to decompression. Some of these patients with bone infarcts have arteriosclerosis, thromboangiitis obliterans, and embolic phenomena as-

sociated with rheumatic heart disease. In a number of cases the cause remains obscure.

Bone infarcts are demonstrable radiologically only at a late stationary stage. They are of two types: the "epiphyseal," at the ends of long bones, adjacent to the joint cortex, and the "metadiaphyseal," in the shaft of the bone. Typical of the "epiphyseal" infarct is a dense area in the cancellous bone abutting on the joint cortex, its distribution often suggesting a "snow cap" over the bone end. The most striking form of the metadiaphyseal infarct resembles a wedge composed of coarse reticulum of calcium density surrounded by a narrow dense line of demarcation.

Twelve roentgenograms.

RICHARD L. JONTZ, M.D.  
Indiana University Medical Center

**Periarticular Soft-Tissue Changes as a Late Consequence of Burns.** Jaromír Kolář and Radko Vrabec. *J. Bone & Joint Surg.* 41-A: 103-111, January 1959. (Charles University, Prague, Czechoslovakia)

Soft-tissue calcification and ossification are frequently seen radiologically as a degenerative development following tissue injury from inflammation, accident, necrosis, or trophic disturbance. The changes occur at the insertions of ligaments and muscles and around joint capsules, so that they are usually located near joints. They may take the form of (1) small linear calcifications, (2) periosteal thickening of varying length and depth, (3) exostoses, or (4) extensive periarticular ossifications which may cause bony bridging of the joint.

Findings of this sort were observed in 25 patients of a group of 750 who had suffered burns and scalds of different extent and degree. The patients were examined by serial x-rays, beginning at admission, and histological studies were also carried out on the periarticular soft tissues. The joints affected were always major ones, especially elbow, knee, and ankle. The changes were never seen about the small joints of hands and feet, and rarely about the shoulder and hip. They appeared from five to six weeks up to as late as two years after injury. All patients had bacterial infections in their burns. The calcifications seemed to develop particularly in joints whose function was impaired.

Prevention of infection and avoidance of joint stiffness are thought to be the best preventives. Attempts to cure well developed calcifications by excision and by hyaluronidase injections have proved ineffective.

Fourteen roentgenograms; 1 photomicrograph.

DON E. MATTHIEN, M.D.  
Phoenix, Ariz.

**Solitary Unicameral Bone Cyst in a Seven-Week-Old Infant.** M. E. Tausend and Milton Marcus. *New England J. Med.* 260: 129-131, Jan. 15, 1959. (Beth Abraham Home, Bronx, N. Y.)

A case of solitary unicameral bone cyst in a seven-week-old infant is reported. At six weeks of age he cried when the right lower extremity was moved. Examination revealed a tender swelling of the anterior middle third of the leg and roentgenograms showed a large central oval defect in the tibia. This was eccentrically expanded; the cortex was reduced to paper thinness and a fine fracture line ran through its anterior aspect into the cyst cavity. The cyst was curetted and packed with paternal bone and bone chips.

Apparently seven weeks is the earliest age at which such a case has been reported. The authors suggest



that the cyst is a congenital developmental defect, and that recent theories suggesting trauma, infection, and tumor as a cause are debatable.

Two roentgenograms with accompanying drawings.

MORTIMER R. CAMIEL, M.D.  
Brooklyn, N. Y.

**The Syndrome of Exophthalmos, Hypertrophic Osteoarthropathy and Localized Myxedema: A Review of the Literature and Report of a Case.** Monroe Thomas Diamond. *Ann. Int. Med.* 50: 206-213, January 1959. (175 King St., Chappaqua, N. Y.)

The author reports a case of hypertrophic osteoarthropathy in a man of 24 years, with localized myxedema following thyroidectomy for Graves' disease. The occurrence of hypertrophic osteoarthropathy in association with diseases of the thyroid has been little mentioned in the literature. Following the surgical procedure in the present case fusiform swellings developed on the hands, between the proximal and distal interphalangeal joints and between the proximal interphalangeal and metacarpophalangeal joints. Swellings were also present over the middle third of the tibial bones of the lower extremities. The skin in these areas seemed red and thickened, with prominent pores, giving a pigskin appearance.

Radiographic examination showed the soft tissue swellings of the fingers and periosteal proliferation and calcification were seen involving the shafts of many of the bones.

A biopsy was taken of the skin over the tibia; the dermal layer appeared to be widened, and between bundles of collagen there was a granular eosinophilic precipitate. The findings were consistent with the diagnosis of localized myxedema.

The patient responded to the use of l-triiodothyronine applied locally.

Two roentgenograms.

THEODORE E. KEATS, M.D.  
University of Missouri

**Degenerative Changes in the Cervical Spine.** Z. B. Friedenberg, Jack Edeiken, H. Newton Spencer, and S. C. Tolentino. *J. Bone & Joint Surg.* 41-A: 61-70, January 1959. (University of Pennsylvania, Philadelphia, Penna.)

The nature and incidence of degenerative bone and joint changes in the cervical spine are discussed at length in this article. The observations are based upon anatomic and roentgenographic studies carried out upon 41 cervical spines with an average of sixty-eight years.

Of all the specimens, 49 per cent revealed disk degeneration between C-5 and C-6 and C-6 and C-7. Disk protrusions did not extend posteriorly into the spinal canal, but were contained by the posterior longitudinal ligament. In no case was disk material found to protrude far enough laterally to be in contact with the nerve root or foramen.

Anterior lipping of the body was present in 25 per cent of the vertebrae examined. In a number of specimens posterior projecting osteophytes produced a deep impression on the anterior surface of the cord. These osteophytes were always seen in association with disk degeneration.

The apophyseal joints have a relatively larger surface area in the upper cervical spine, where they may be assumed to carry a larger proportion of the weight of

the head. Accordingly, the most severe apophyseal joint changes were noted between the second and third vertebra. By contrast, at the fifth and sixth levels there was increased incidence of degenerative changes in the disks and in the joints of Luschka, as well as a higher incidence of disk protrusions and of osteophytes on the bodies.

On examination of 27 cervical spines cleared of soft tissues, there was found to be close correlation between the bony degenerative changes and the degenerative changes in the intervening disks. In the absence of disk degeneration it was unusual to find other abnormalities, at least by x-ray.

Roentgenographic examinations with conventional anteroposterior, lateral, and oblique views were carried out on 41 specimens. The roentgen and anatomic manifestations of disk degeneration were in agreement in 67 per cent. In 83 per cent roentgenographic changes in the joints of Luschka were proved by dissection. There was poor correlation between the changes seen radiographically and the anatomic findings in the apophyseal joints. The fact that severe apophyseal joint changes were usually seen in the presence of a normal disk space, seems to indicate that they have separate degenerative mechanisms.

It is emphasized that, when disk thinning is accompanied by reactive bone formation on the joints of Luschka, spurs may form beneath the nerve root as it emerges through the foramen and may produce radiating pain. At times, when extensive, the excrescences may also encroach upon the foramina for the vertebral vessels; this is believed to cause reduced blood flow or arterial spasm in the vertebral artery.

Five photographs; 1 chart; 6 tables.

DON E. MATTHIASEN, M.D.  
Phoenix, Ariz.

**On Surgically Treated Herniated Intervertebral Discs.** Bertil Knutsson and Gunnar Wiberg. *Acta orthop. scandinav.* 28: 108-123, 1958. (University Hospital, Lund, Sweden)

During the years 1945 to 1953, 267 patients were operated upon in the Department of Orthopedic Surgery, University Hospital, Lund (Sweden) for herniated intervertebral disk by the same surgeon (Professor Wiberg). Sixteen of this number had had previous surgery and are therefore excluded from the present analysis. This leaves 251 patients, of whom 134 were males and 117 females, ranging in age from sixteen to sixty-eight years. The protrusion was right-sided in 121 cases, left-sided in 128, and bilateral in 2.

**Clinical Findings:** Weakness in dorsal flexion of the great toe was observed in 58 of 82 patients (or almost 71 per cent) in whom operation disclosed protrusion or prolapse of the disk between the fourth and fifth lumbar vertebrae. Of those patients in whom paresis of the great toe could be demonstrated, protrusion or prolapse of the disk between the fourth and fifth lumbar vertebrae was found at operation in 63 per cent. Of a total of 133 prolapses of the disk between the fifth lumbar and first sacral vertebrae, the Achilles reflex was weak or absent in 111 (83 per cent).

**Myelography:** Myelography with air-oxygen was performed in 80 cases. Of those cases in which myelography showed disk protrusions, it was herniations between the fifth lumbar and first sacral vertebrae that were found with highest frequency at operation. In only 1 out of 10 cases did operation fail to confirm positive

myelographic evidence of protrusion of the disk between the fifth lumbar and first sacral vertebrae. If myelography suggests a prolapse in the lumbosacral region where the spinal canal is particularly wide, the herniation is usually large enough to produce a filling defect in the contrast medium at the level involved.

Of 34 cases in which myelography suggested prolapse of the disk between the fourth and fifth lumbar vertebrae, the finding was confirmed at operation in 26 (77 per cent).

Myelography showed no evidence of a pathologic condition in 32 cases. Surgical exploration of the lumbosacral space revealed herniation of the intervertebral disk in 9 out of 13 cases, confirming the observation that, because of the width of the spinal canal in the lumbosacral region, myelography may fail to demonstrate slight protrusion.

In 4 out of 11 cases operation revealed a herniated disk between the fourth and fifth lumbar vertebrae in which myelography had failed to show any signs of a pathologic condition.

Of 32 cases in which myelography with contrast medium U indicated protrusion of the disk between the fifth lumbar and first sacral vertebrae, operation confirmed the roentgen finding in 29 (91 per cent). The corresponding figures for the disk between the fourth and fifth lumbar vertebrae were 26 of 28 (93 per cent).

In 9 out of 11 cases in which myelographic examination with contrast medium U failed to demonstrate any changes, operation disclosed a disk between the fifth lumbar and first sacral vertebrae. In only 1 case did myelography miss a protrusion of the disk between the fourth and fifth lumbar vertebrae found at operation.

The use of electromyography in the diagnosis of the level of disk protrusion is discussed.

Two hundred and forty-one of the 251 patients who had been operated on four to twelve years previously replied to a questionnaire. Improvement was reported by 94.5 per cent; the remaining 5.5 per cent reported no change or deterioration.

Eight tables.

**Discography in Low Back Pain and Sciatica.** Analysis of 73 Operated Cases. Sverker Nordlander, Ernst F. Salén, and Lars Unander-Scharin. *Acta orthop. scandinav.* 28: 90-102, 1958. (Karolinska Institutet, Stockholm, Sweden)

While the use of various myelographic techniques, of which myelography with water-soluble contrast medium seems to be the most suitable, has facilitated the diagnosis of disk herniation, it does not reveal all types of prolapse. The herniation may be so small or at such a site that it does not make any impression in the dural sac or in the opacified root sheath; this is particularly true in the case of the lumbosacral disk. Discography, according to the technic originally described by Lindblom (*Acta radiol.* 34: 321, 1950. *Abst. in Radiology* 57: 612, 1951), might be expected to disclose which disk was responsible for the pain, as well as the type of pain, i.e., lumbago or sciatica.

Since 1948, discography has been carried out in more than 500 cases in the Roentgen Diagnostic Department of Karolinska Sjukhuset. A detailed clinical and roentgenologic analysis has been made of 73 patients who underwent operation. In most of these cases, both myelography and discography of the three lowest lumbar disks were performed. This investigation failed to show that discography is superior to myelography for the routine diagnosis of herniation of an intervertebral disk.

The authors believe that the two methods of examination are complementary and that discography is indicated in certain cases. In severe cases of low back pain and sciatica, where conservative treatment has failed and myelographic findings are inconclusive, discography should be of value; also in cases with pain of uncertain origin, in which spinal osteosynthesis is contemplated. Discography is also useful in insurance cases when a complete roentgen analysis is desirable. In postoperative cases, in which the myelographic changes cannot be distinguished with certainty from recurrent disk herniation, discography, with particular attention to the pain elicited by injection of contrast medium, may allow localization of the disk responsible for the current symptoms.

Ten roentgenograms; 4 tables.

**Sarcoidosis with Vertebral Involvement.** Theodore Rodman, Eugene E. Funderburk, Jr., and Ralph M. Myerson. *Ann. Int. Med.* 50: 213-218, January 1959. (VA Hospital, Philadelphia, Penna.)

The authors report a case of sarcoidosis involving the vertebrae, which they believe to be the first published example of the disease with a definite antemortem diagnosis of such involvement. The protean manifestations of sarcoidosis are well known but vertebral sarcoidosis is apparently rare.

The patient, a 33-year-old Negro, presented with a history of abnormality of the chest detected three years earlier on a routine roentgenologic examination. Biopsy of a cervical lymph node had led to a diagnosis of sarcoidosis. Films showed a diffuse reticular pattern involving both lungs, thought to be consistent with sarcoidosis. Tuberculin and fungus skin tests were negative. Lateral planigrams of the vertebral column showed a lytic lesion of the eleventh and twelfth thoracic vertebrae.

The course in the hospital was marked by recurrent febrile episodes associated with bouts of paralytic ileus.

Serial x-rays of the thoracic vertebral lesion showed rapid progression of the lytic process, and biopsy was carried out with fusion. The biopsy showed noncaseating granulomata consistent with sarcoidosis. Special stains for acid-fast bacilli were negative, as were cultures for tubercle bacilli, fungi, and pyogenic organisms. Following spinal fusion, the patient did well and was discharged, wearing a back brace. A follow-up examination showed good healing.

Two laminagrams; 2 photomicrographs.

THEODORE E. KEATS, M.D.  
University of Missouri

**Circulatory Disturbances in Osteoarthritis of the Hip. A Venographic Study.** Anders Hulth. *Acta orthop. scandinav.* 28: 81-89, 1958. (Orthopedic Department, Academic Hospital, Uppsala, Sweden)

The head of the femur was studied by intraosseous venography in 15 patients with unilateral or bilateral osteoarthritis of the hip. In the venogram of the osteoarthritic hip, there is a retention of contrast medium in the femoral head for fifteen minutes or more, due to the altered cancellous bone tissue of the joint. The more severe the disease, the more intensive and expansive the accumulation of medium at the site of the injection. In the normal hip the contrast material immediately leaves the bone and enters the femoral-iliac veins. In diseased

hips it has to traverse a much longer intra-osseous route before entering the extra-osseous veins, *i.e.*, the femoral veins, evacuation occurring mainly *via* medullary veins coursing distally into the femoral shaft.

The injection of the medium into the osteoarthritic joint produces pain, while that into the normal or little affected hip is almost painless. The possibility of arthritic pain being partially caused by the impaired outflow of venous blood is discussed.

Seven roentgenograms.

**Coxa Plana.** Beckett Howorth. *Arch. Pediat.* 76: 1-16, January 1959. (Greenwich Hospital, Greenwich, Conn.)

Coxa plana is a vascular disturbance of the capital epiphysis of the femur, running a self-limited course. It is more common in boys than in girls in a ratio of about 6 to 1; it occurs with equal frequency in either hip, and about 15 per cent of the cases are bilateral. The age incidence is between four and ten years, but the condition may be seen in younger children under treatment for congenital dislocation of the hip. Similar degenerative changes, also due to vascular damage, occur in older children in the course of treatment of slipping of the upper femoral epiphysis and in adults with fracture of the neck of the femur.

Very early recognition of the synovitis which precedes development of coxa plana, with prompt institution of non-weight-bearing, appears to result in the abortion of at least some of the cases.

The roentgen appearance in the various stages is quite characteristic. The first evidence is a globular swelling of the capsule. A few weeks after onset, the epiphyseal line appears wider and there is irregular decalcification at the proximal end of the neck. The joint space seems wider—inferiorly because of the slight lateral subluxation and superiorly because of flattening of the ossified portion of the capital epiphysis—but there is no change in the shape of the articular cartilage. An irregular dense area is soon evident in the capital epiphysis, usually in the central or lateral portion. This gradually shows uneven decalcification and may at the same time become more extensive. During this period, the head becomes thinner, flatter, and wider, and the neck shorter and thicker. The soft-tissue swelling gradually subsides; the proximal end of the neck recalcifies, becomes convex, and grows into the head. Recalcification of the decalcified portion of the head progresses more slowly. Eventually normal trabeculation occurs, but the head retains its mushroom shape and the subluxation persists. The acetabulum usually tends to conform to the shape of the head, and osteoarthritic changes may be seen in later life.

Present-day therapy consists basically of preventing damage to the hip while the disease runs its course and regeneration takes place.

Twenty-two roentgenograms; 1 photomicrograph.

**Traumatic Dislocation of the Radial Head as an Isolated Lesion in Children. Report of One Case with Special Regard to Roentgen Diagnosis.** Gunnar Støren. *Acta chir. scandinav.* 116: 144-147, 1959. (Sandnes Sykehus, Sandnes, Norway)

A case of isolated dislocation of the radial head in a 6-year-old boy, who was said to have fallen with his arm under him, is reported. The boy suffered severe pain, a swelling appeared on the radial aspect of the elbow joint, and mobility was greatly restricted. Roentgen

examination revealed no striking changes and the appearances might at first sight have been interpreted as normal. However, a line extending the axis of the radius upward passed slightly in front of the center of the capitellum instead of through it, as is normal. Reduction was performed, and subsequent roentgenograms showed the anatomic relations to have been restored.

When the radial head is markedly displaced anteriorly, both clinical and roentgen diagnosis is obvious. In the case presented, however, the suspicion raised by the clinical features might not have been verified roentgenologically if the relation between the radial axis and the capitellum had not been investigated. In children, in whom the epiphyseal ossification centers have not yet appeared and the gap between the bone ends on the roentgenogram is consequently wide, interpretation of the relationship between the bone ends may cause difficulty. The fact that in lateral projection a line extending the axis of the radius should pass through the center of the capitellum *in all degrees of flexion of the elbow* is worthy of special note, though it may appear obvious.

Five roentgenograms; 6 drawings.

**Study of Congenital Meniscal Malformations by Pneumarthrography.** J. Philippon. *J. de radiol.* 40: 1-6, January-February 1959. (In French) (Algiers, Algeria)

In performing 700 pneumarthrographic studies, the author found 13 congenital malformations of the meniscus of the knee. The normal medial or internal meniscus is about 4 mm. thick and 10 to 15 mm. in length along the capsular border. The lateral or external meniscus is 4 to 6 mm. in thickness and 14 to 20 mm. in length.

The congenital anomalies consist of megameniscus or discoid meniscus, annular meniscus, and small meniscus or micromeniscus.

Excellent reproductions demonstrate the findings. Nine roentgenograms; 1 photograph; 2 tables.

CHARLES M. NICE, JR., M.D., Ph.D.  
Tulane University

**Non-Union of a Fracture of the Anterior Superior Process of the Calcaneus. Case Report.** Jack Levine, Abel Kenin, and Morton Spinner. *J. Bone & Joint Surg.* 41-A: 178-180, January 1959. (20 Plaza St., Brooklyn 38, N. Y.)

This is the report of a fracture of the anterior superior process of the calcaneus which was unrecognized on the initial films. The patient had continuing pain in the foot, which was relieved when an ununited fracture segment was finally identified and excised. The author points out the necessity for oblique foot views for proper appraisal of these injuries.

Four roentgenograms.

DON E. MATTHIASEN, M.D.  
Phoenix, Ariz.

## THE SPINAL CORD

**Postoperative Dissemination of Astrocytoma of the Spinal Cord Along the Ventricle of the Brain. A Case Report.** D. M. Perese, A. Slepian, and G. Nigogosyan. *J. Neurosurg.* 16: 114-119, January 1959. (Roswell Park Memorial Institute, Buffalo, N. Y.)

Spontaneous dissemination of primary spinal cord tumors is extremely rare in comparison with primary

brain tumors metastasizing along the neural axis as well as to other organs.

Postoperative spread of spinal cord tumors is also uncommon. The authors found only two references to such a spread, involving 3 cases—2 ependymomas and an ependymoma and oligodendroglioma. They report here a case of Grade I-II astrocytoma of the conus medullaris which seeded along the cervical spinal cord and ventricles of the brain postoperatively. No similar case could be found in the literature. The question is raised whether manipulation of the cord during surgery or the three courses of heavy irradiation administered to the conus medullaris postoperatively, or both, may have played some part in the dissemination of the tumor.

Three photomicrographs; 1 photograph.

EUGENE A. CORNELIUS, M.D.  
Houston, Texas

**Lateral Intrathoracic Meningocele.** Roland Bunner. *Acta radiol.* 51: 1-9, January 1959. (Sabbatsbergs Sjukhus, Stockholm, Sweden)

A lateral intrathoracic meningocele is a sacular protrusion of the dura through an enlarged intervertebral foramen which extends anteriorly between the ribs displacing the parietal pleura forward. It is thus to be differentiated from neurofibroma with intraspinal extension—hourglass tumor.

Two cases of intrathoracic meningocele, both symptomless, discovered on mass miniature chest surveys are reported. The illustrations in each case demonstrate the enlarged foramen together with rib and posterior vertebral body erosion, the latter sign best seen in the tomographic studies. Diagnosis was confirmed by pneumomyelography (180 ml. oxygen introduced after withdrawal of a like amount of spinal fluid).

Both patients, one a 43-year-old female and the other a 36-year-old male, had Recklinghausen's neurofibromatosis. The author's review of the literature shows that neurofibromatosis co-exists with intrathoracic meningocele more commonly than with neurinoma.

Seven roentgenograms.

GEORGE L. SACKETT, M.D.  
Cleveland, Ohio.

## GYNECOLOGY AND OBSTETRICS

**Experience with New Contrast Media for Hysterosalpingography.** H. E. Reiss and Maria E. Grossmann. *J. Obst. & Gynaec. Brit. Emp.* 65: 782-787, October 1958. (University College Hospital, London, England)

On Jan. 1, 1956, the authors discontinued the use of polyvinylpyrrolidone-containing contrast media for hysterosalpingography and started an investigation into the suitability of other existing contrast agents for this purpose. Two hundred women with primary or secondary infertility or repeated abortions were examined.

Uridone 35 is identical with Diodone B.P. 35 per cent. This substance, prepared for intravenous pyelography, was employed in only 8 patients; it was discarded because of its low viscosity and its poor radiopacity.

Endografin and Bilografin are chemically identical substances, but they differ in contrast intensity and viscosity. Neither contains any supplementary thickening agent, so that the viscosity depends entirely on the size of the molecule and the concentration. Endo-

grafin 70 per cent was used in 23 cases, but was discontinued because of its high viscosity and intense radiopacity, which obscured at times the mucosal pattern of the uterus, tubes, and cervical nodes. Furthermore, pain of delayed onset was a frequent complaint. Bilografin, originally developed for cholangiography, was tried in the next 16 cases. Contrast was unsatisfactory with the 30 per cent solution, while the 50 per cent solution produced severe peritoneal irritation and pain which was maximal from one to three hours after the examination. The viscosity of Bilografin was also considered to be somewhat low, resulting in poor visualization of the tubes and too rapid spill in some instances.

The authors next tested Urografen, which is available in concentrations of 76 per cent and 60 per cent. In 5 cases the weaker preparation was used, but the 76 per cent solution proved superior and was employed in the remaining 148 cases. This medium is the least toxic of all media developed to date. It was found to be safe; it mixed well with body secretions and the contents of hydrosalpinges and gave satisfactory contrast without obscuring fine details. It was completely absorbed in a short time, and in the majority of cases two films were adequate for diagnostic purposes. Severe pain was encountered in only 1 case and moderate pain in 2. There were no other objective or subjective ill effects in the present series.

Six roentgenograms.

## THE GENITOURINARY SYSTEM

**Perirenal (Gerota's) Fascitis.** John A. Hutch, Ray C. Atkinson, and George S. Loquvam. *J. Urol.* 81: 76-95, January 1959. (J. A. H., 2100 Monument Blvd., Pleasant Hill, Calif.)

The authors review 21 cases and present 2 additional examples of "perirenal fascitis." The cardinal symptom of this condition is complete anuria due to ureteral compression by a dense, grayish-white fibrous connective tissue thought to result from inflammation of the perirenal (Gerota's) fascia. An attempt is made to establish this disease as a clinical entity, to differentiate it from periureteritis plastica to which it may be related, and to establish early diagnostic criteria.

No one symptom or symptom complex is diagnostic. The only significant physical finding is the occasional presence of a palpable mass over the sacral promontory. The urinary findings are non-specific. Radiological examination shows the involved segment within the plaque, lying medial to its normal position. The ureter here is narrowed, beaded, and may be difficult to visualize. In the retrograde examination the ureteral catheters encounter a "tightness" in the involved area. The proximal ureter is often dilated.

The fibrous tissue plaque may produce obstruction of the internal spermatic vessels, the abdominal aorta, or vena cava, presacral plexus, or even intestinal obstruction as a result of adhesions. The area involved is usually between the aortic bifurcation above and the sacral promontory below, though the upward course varies and may extend along the lumbar vertebrae to the ureteropelvic junction and around the kidney. Pathologically, most of the plaques consisted of dense, fibrous connective tissue with varying quantities of fat and inflammatory cells.

The surgical treatment and results are discussed and the conclusion is drawn that those patients in whom



nephrostomy was instituted early did the best. Some authors prefer to pass ureteral catheters to the kidneys. Several surgical approaches are possible in freeing the ureters from the fibrotic plaque.

Nine roentgenograms; 4 photomicrographs; 4 photographs; 13 diagrams; 1 table.

CARL KAPLAN, M.D.  
University of Pennsylvania

#### Delayed Cystography: A Valuable Diagnostic Tool.

William H. Browning, D. Cramer Reed, and Harold O'Donnell. *J. Kansas M. Soc.* 60:22-24, January 1959. (427 N. Hillside, Wichita, Kans.)

Delayed, or retrograde, cystography is a simple procedure and should be considered a necessary part of every pediatric urologic examination. It is a specific test for vesicoureteral reflux and has been said to be the most helpful of all urographic procedures in the study of vesical neck obstruction in children. It consists in an (a) x-ray visualization of the urinary bladder and kidney areas at intervals after the introduction of opaque medium into the bladder; (b) roentgen demonstration of the same areas during the act of micturition of the medium or immediately thereafter.

The authors introduce the contrast medium—in their case Urokon 20 per cent—by gravity through a catheter into the bladder. There should be adequate filling but, since the medium may remain in the bladder for ninety minutes or longer, sufficient space should be left for an additional natural increment of urine. Films are exposed at intervals of fifteen to thirty minutes until ninety minutes have elapsed or until visualization of reflux has taken place. At this point the child is urged (more often allowed) to void, and a film is exposed during the act of micturition. A post-voiding film, the last, is taken immediately afterward. For the child who is unable to cooperate, the voiding cystogram is dispensed with, but great care is taken to obtain an immediate postvoiding film.

Two cases are reported.

Four roentgenograms.

**Experiences with Thixokon: The New Urethrographic Medium.** David W. Goddard. *J. Urol.* 81: 225-226, January 1959. (135 Broadway, Daytona Beach, Fla.)

The author offers observations based upon 400 urethrograms performed with Thixokon, a non-gelling, starch-thickened, aqueous solution of 3-acetamido-2, 4, 6-triiodobenzoic acid.

Roentgenograms were of uniformly good quality and the water-miscible medium provided fine detail. After-effects were minimal; vascular emboli were no problem; and the medium was discharged completely by the bladder. While anaphylactic reactions to the organic iodide are a possibility, no such reactions were encountered in this series.

The author considers urethrography an exceptionally worthwhile diagnostic study which not only enlightens the urologist as to the existence of urethral strictures but also provides an intelligible picture useful in educating the apprehensive patient to a better understanding of his problem. Urethrography with Thixokon medium is suggested as a safe and reliable diagnostic measure which deserves greater use.

DAVID E. KUHLE, M.D.  
University of Pennsylvania

**A New Test for Vesicoureteral Reflux: An External Technique Using Radioisotopes.** Chester C. Winter. *J. Urol.* 81: 105-111, January 1959. (University of California Medical Center, Los Angeles, Calif.)

The author describes preliminary experimental and clinical studies of a new tracer technic for determining reflux up one or both ureters simultaneously, through the use of external radiation detection and recording equipment. Radioactive material was introduced into the bladder through a Foley ureteral catheter and allowed to reflux up the ureter(s). Gamma-ray scintillator counters were directed toward the anterior aspect of each kidney with the patient in the supine position. A continuous tracing was obtained of the amount of radiation emanating from each kidney, indicating reflux. The findings correlate well with roentgenograms obtained by introducing a contrast medium into the bladder of these patients.

Dual units of lead-shielded, gamma-ray scintillation counters, rate meters or spectrometers, and Esterline-Angus recorders were used. Radioisotopes utilized for instillation into the bladder were rose bengal- $I^{131}$  and Diodrast- $I^{131}$  in doses of 3 to 7  $\mu$ c. The former is not absorbed through the bladder.

Investigators in the past have studied vesicoureteral reflux through the use of periodic roentgenograms following instillation of contrast medium into the bladder. This method is time-consuming and frequently tiring and involves repeated exposure of the patient to irradiation. The amount of radioisotope used is minute and radiation exposure is negligible. Not infrequently, intermittent ureteral reflux may occur only during intervals between x-ray exposures and thus remain undetected by routine methods.

Twelve figures, including 7 roentgenograms.

JOSEPH M. WINSTON, M.D.  
University of Pennsylvania

**The Use of X-Ray Cinematography in Urological Studies.** John A. Benjamin. *J. Urol.* 81: 227-231, January 1959. (University of Rochester School of Medicine and Dentistry, Rochester, N. Y.)

This paper was originally presented as the Ballenger Memorial Lecture to the Southeastern Section of the American Urological Association, with an accompanying cine demonstration. The published paper suffers from inability to duplicate this form of presentation.

The author describes the physiology of the upper urinary tract in respect to the movement of contrast material from the calyces through the renal pelvis and ureters into the bladder. A brief description of the mechanics of voiding is also included.

Several cases are presented in which cinefluorography helped pinpoint anatomical or functional abnormalities present in the urinary tract.

In summary, the author reaffirms his belief in cinefluorography as a unique and valuable procedure to study urologic problems concerned with both functional and structural disorders.

ROBERT JACOBS, M.D.  
University of Pennsylvania

**Functional Characteristics of the Ileal Segment as a Valve.** Frank Hinman, Jr., and Rudolf Oppenheimer. *J. Urol.* 80: 448-454, December 1958. (University of California School of Medicine, San Francisco, Calif.)

The properties of ileal loops employed in urology were studied in 3 human patients and in 34 dogs by means of



cineradiography and continuous direct pressure recordings. The contractions of the ileum include "mixing" movements, which are of low amplitude and independent of the degree of distention, and propulsive movements, initiated by intraluminal pressure changes through local reflexes mediated by intrinsic nerve supply, and affected by many external factors, such as drugs and emotions. The effectiveness of peristaltic expulsion varies directly with intraluminal pressure and with the rate of filling.

The resistance of the ileum to retrograde flow was studied by cineradiography, by measurement of pressure in the ileal cystostomy, and by observation of voiding in dogs through their cystostomies. The longer the anti-peristaltic ileal segments the greater was the resistance to flow but an interposed ileal loop is not an effective valve. An intussusception in the segment appears to increase significantly its valvular properties.

The conclusion is reached that, "although ileal peristaltic activity may reduce the back pressure effects of pressure less than 15 cm. of water, little dependence can be placed on ileal peristalsis alone for the prevention of reflux at usual voiding pressures in ileal segments interposed between kidney and bladder or kidney and bowel."

Nine figures.

D. J. RITCHIE, M.D.  
University of Pennsylvania

**The Voluntary Control of Micturition in Man.** S. Richard Muellner. *J. Urol.* 80: 473-478, December 1958. (520 Beacon St., Boston 15, Mass.)

The structure of the pelvic floor and the complete control of the urinary bladder in man are unique among mammals and cannot therefore be studied in the experimental animal. The present report is based on about 1,000 fluoroscopic examinations. These indicate that man cannot "will" the smooth muscle detrusor to contract and therefore allow the internal sphincter to open. Instead, the voluntary mechanism seems to involve the steadying of the thoracic diaphragm, the contraction of the lower abdominal musculature, and the relaxation of the pubococcygeus muscle. This directs the intra-abdominal pressure toward the vesical neck and causes it to descend. It is this descent that acts as a stimulus for the detrusor to contract. This view of the mechanism of voluntary control of micturition is supported clinically by the fact that the patient who has undergone surgery on the abdominal or perineal musculature frequently cannot void voluntarily after operation.

The bladder base, instead of the dome, appeared to be the main pump during micturition. This would explain why most of the bladder wall thickening takes place at the base in cases of outlet obstruction.

The greater the stretch put on the detrusor, as with a full bladder, the more readily does the detrusor contract. Micturition which takes place as a result of such a stretch reflex, called detrusor micturition, is seen commonly in children and animals.

The author feels that voluntary inhibition of the urinary stream occurs through contraction of the levator ani muscle. Recent experimental evidence, which tends to cast a doubt on the function of voluntary mechanisms in micturition, is critically reviewed.

Four roentgenograms; 2 diagrams.

S. DAVID ROCKOFF, M.D.  
University of Pennsylvania

## MISCELLANEOUS

**Regeneration of Surgically Divided Lymph Vessels. An Experimental Study on the Rabbit's Ear.** Sven Bellman and Bo Odén. *Acta chir. scandinav.* 116: 99-117, 1959. (Karolinska Institutet, Stockholm, Sweden)

In the present investigation a microlymphangiographic technic, which has been described previously (*Acta radiol.* 47: 289, 1957. *Abst. in Radiology* 70: 304, 1958), was applied to the study of healing and regeneration of surgically divided lymphatics in the rabbit's ear. Observations were made both *in vivo* and on fixed material. It was found that dilatation developed in the large central lymph trunks distal to all long incisions, and that extensive retrograde penetration of contrast material in the lymph vessel system distal to the incision also occurred. Most short incisions caused no dilatation of the large trunks, but gave similar, although somewhat less extensive, retrograde penetration of contrast medium into the lymphatics in the distal part of the ear.

Connections between distal and proximal lymphatics were almost always established early around short incisions, *via* circumventing paths in the pre-existing net of anastomosing lymphatics. Some parts of these bridging arcades showed a retrograde flow of contrast medium as compared with the anatomical arrangement of the lymph vessel valves. Usually these arcades increased in diameter during the first week or so after the incision; in some cases they later gradually disappeared, as connections through the incision were established, but in many instances they remained visible throughout the experiments. After long incisions, this type of circumventing connection was fairly rare.

Lymph vessels large enough to be seen in microangiograms developed across all long incisions and about two-thirds of the short ones. The earliest demonstration of traversing connections in long incisions was after about one to two weeks; in short incisions usually after two to three weeks.

As the distal and proximal lymphatics became connected in the case of the long incisions, the distal dilatation of the central large lymph trunks of the ear disappeared. The retrograde migration of contrast medium in the lymphatics distal to the incision usually remained somewhat longer. It also continued for several weeks after short incisions—in fact usually longer than after the long ones—in spite of the anatomically substantial connections established around them. Whether other factors than mechanical stasis, *e.g.*, autonomous denervation by the division of the posterior auricular nerve, or possible effects from the deposition in the tissue of repeatedly injected contrast material, had anything to do with the retrograde penetration of contrast material in lymphatics distal to the line of incision is not clear.

The end-result, as seen after two to eleven months observation, was usually a normal lymph vessel pattern distal and proximal to the scar. Through long scars there were demonstrable lymph vessel connections, varying in size, shape and number. A few also had circumventing lymph vessels. About two-thirds of the short scars showed similar lymph vessel connections, and many had circumventing arcades—often substantial—between distal and proximal lymphatics.

Sixteen microlymphangiograms.

**Torulosis.** M. G. F. Donnan. J. Fac. Radiologists 10: 17-20, January 1959. (Royal Perth Hospital, Perth, Western Australia)

Torulosis, caused by *Cryptococcus neoformans*, may present clinically in many ways according to the system involved and rate of proliferation of the organism.

Histologically, the miliary nodule is the commonest pathological lesion. Where there is a paucity of organisms, a fibrotic granuloma may be produced; where there is massive proliferation of Cryptococci, the lesion may be a gelatinous mass.

The organism may enter through the skin, intestinal tract, or, most commonly, the respiratory tract. There is believed to be a stage of septicemia from which many different organs can become involved. Involvement of the brain and meninges is almost uniformly fatal. Isolated lung lesions have been resected with apparent cure.

The author reports 5 cases of torulosis which demonstrate very well the diverse manner of presentation of the disease and indicate the difficulty in diagnosis. Two of these were previously published (Fortune, Donnan, Colebatch, and Lubbe: M. J. Australia 2: 199, 1955. Abst. in Radiology 67: 633, 1956). Increased awareness of the disease and its varying manifestations may lead to more antemortem diagnoses and perhaps specific curative therapy in the future.

One roentgenogram; 1 photomicrograph; 3 photographs.

MAJ. BYRON G. BRODGON, M.C.  
Lackland AFB, Texas

## TECHNIC

**Current Indications for Roentgen Cinematography.** G. Candardjis and M. Bugnion. Schweiz. med. Wchnschr. 89: 72-76, Jan. 17, 1959. (In French) (Institut universitaire de radiologie, Lausanne, Switzerland)

The authors differentiate between direct and indirect roentgen cinematography. The first consists in the use of rapid film changers with relatively large film (as the Schönander-Elma units). This method is useful when large films with good detail are required. Indirect roentgen cinematography refers to the use of a motion picture camera to record the images which appear on the fluoroscopic screen. This is even more useful than the direct method when dynamic studies are desired. For example, in angiocardiology, the motion picture camera may show the presence of shunts and other movements which escape accurate analysis when only six to twelve views per second are obtained.

Apparently the gastrointestinal and urinary tracts are the other systems in which the motion picture camera may be used with hopes of obtaining added information. Motion picture studies have proved of value in the investigation of functional disturbances of the esophagus and stomach, and many organic diseases causing rigidity in the walls of these viscera. To date, they have been of less definite usefulness in study of the bronchial tree and the locomotor system.

CHARLES M. NICE, JR., M.D., Ph.D.  
Tulane University

## RADIOTHERAPY

**The Treatment of Retinoblastoma by X-Ray and Triethylene Melamine.** A. B. Reese, G. A. Hyman, Norah duV. Tapley, and A. W. Forrest. Arch. Ophth. 60: 897-906, November 1958. (73 E. 71st St., New York 21, N. Y.)

In 1955 (Arch. Ophth. 53: 505, 1955. Abst. in Radiology 66: 314, 1956), the authors reported favorable results with the treatment of retinoblastoma by a combination of x-radiation and the radiomimetic drug, triethylene melamine (TEM), administered orally. Later that year the oral form of TEM was discarded because emesis and irregularity of absorption interfered with the accuracy of the dosage, especially when leukopenia or thrombopenia did not develop, and a parenteral preparation was substituted. Since that time 19 consecutive suitable cases have been treated by the combination of 3,250 r and TEM injected intramuscularly; to date 17 of the 19 tumors (89 per cent) appear to be arrested.

Radiation alone may cure retinoblastoma but, so far as is known, TEM alone will not. The two seem to be synergistic or supplementary. To establish whether results with the combined use of x-rays and TEM are superior to those with x-ray therapy alone, 12 favorable and as nearly comparable cases as possible were selected. Six eyes were treated with x-rays alone and 6 with x-rays and TEM. Three tumors in the first group of eyes showed active growth after treatment was completed, and 3 tumors are arrested to date. The 3 failures were then treated with x-rays and intra-arterial TEM, and all 3 tumors appear arrested to date. The 6 eyes in the alternate series, treated with x-rays and intramuscular TEM, all appear to be arrested.

Instillation of TEM under direct observation into

the carotid artery on the side of the involved eye has been employed in certain selected cases. Thirty-one children with advanced intraocular disease were treated by this technic, with a total of 61 intracarotid injections, and in 14 cases a favorable response was obtained. Only one immediate toxic effect was encountered, an epileptic seizure in a child at four and twenty-four hours after the administration of TEM, which was not associated with any later sequelae. The systemic effects are exactly the same as with intramuscular TEM—immediate nausea and vomiting, as well as occasional fever for twenty-four to forty-eight hours in the smaller children. These symptoms are controllable, if necessary, by use of chlorpromazine.

The authors emphasize the extreme caution that therapy with TEM requires. They feel that a maximal depression to approximately 3,000 leukocytes and/or a maximal depression of approximately 100,000 platelets indicates that the patient has received an adequate dose of TEM. Fifty per cent of a group of children receiving 0.1 mg. TEM per kilogram intra-arterially had white cell counts below 3,000, ranging from approximately 1,400 to 3,000. In addition, 33 per cent of the children had platelet counts below 100,000, and in 1 case a platelet count of 25,000 was reached. It is routine to treat any child whose white blood cell count drops below 2,000 with a tetracycline derivative and any child whose platelet count drops below 100,000 with prednisone, and this therapy is continued until the white cell count rises above 3,000 and the platelet count above 100,000. Since no therapeutic results can be expected unless hematologic depression occurs, and since hematologic depression is a measure of the therapeutic effect, it can easily be seen how narrow is the margin during

the administration of TEM and x-ray therapy in combination in these very young patients.

The technics of irradiation and of the intracarotid injection of TEM are described. Following treatment there are three ways by which the lesion manifests itself in the arrested stage. The commonest is observed between the third and fourth weeks, when the tumor clinically disintegrates into calcium, which undergoes absorption until ultimately there may be little or no trace of the tumor. In other cases no calcium is demonstrable but the net result is seen as a grayish-white, avascular mass considerably smaller than the original. Still another manifestation is a lesion the central part of which is calcified while the periphery is a grayish, homogeneous, avascular tissue, surrounded by a zone of atrophy and pigment disturbance. The type of residue may be determined by the exophytum or endophytum character of the tumor.

The authors believe that a cure rate of 90 per cent with combined x-ray therapy and intramuscular triethylene melamine is not too much to be expected. In the series reported earlier, in which the TEM was given orally, not one tumor has shown recurrent growth. Advanced intraocular lesions for which in the past enucleation would have been advised show arrested growth, to date, in 60 per cent of the cases with administration of TEM by way of the carotid artery. It is too early and no doubt too optimistic to claim or expect cure in all of these.

Seven figures.

**Neuroblastoma Originating from Olfactory Epithelium (Esthesioneuroblastoma).** Paul A. Riemschneider and John T. Prior. *Am. J. Roentgenol.* **80**: 759-765, November 1958. (Syracuse Memorial Hospital, Syracuse 10, N. Y.)

The authors report a case of esthesioneuroblastoma arising from olfactory epithelium in the nasal fossa, with apparent total independence of the central nervous system. Postmortem, metastatic spread by extrusion of cells into the cerebrospinal fluid was disclosed.

The patient, a 67-year-old man, was first seen in February 1956. The diagnosis at that time, following biopsy studies, was "anaplastic epithelial type carcinoma, presumably of transitional-cell type." As a result of this report, the patient received deep roentgen therapy through five portals aimed at the mass in the nose and nasopharynx over a period of six weeks to a total estimated tumor dose of approximately 6,000 r. The factors of irradiation were 220 kv, 15 ma, 2 mm. Cu h.v.l., and a target-skin distance of 50 cm. Each portal measured 6 × 8 cm. By April there was marked improvement, and no gross mass was visible. In May the skin had healed well in the area where there had been radiation reaction, and roentgenograms of the sinuses showed no evidence of a mass. In July the patient complained of sacral and coccygeal pain and sphincter incontinence. Disease progressed rapidly and death occurred on Aug. 15.

At necropsy, a white, necrotic, 3-cm. mass was found on the cribriform plate of the ethmoid, beneath the dural membranes. It extended through the cribriform plate into the superior nasal conchae and had also spread laterally along the lateral walls of the orbit. The bones of both orbital cavities were eroded. Discrete firm masses were attached to both the spinal cord and the cauda equina from L-5 to D-12, being most numerous in the region of L-4, where they effectively blocked the

cord. Sections of the tumor from within the nasopharynx and spinal cord were examined by Dr. Fred W. Stewart (Memorial Hospital, New York), who pronounced it a neuroblastoma.

The difficulties of microscopic diagnosis are pointed out. Tumors to be differentiated include the lymphomas, embryonal rhabdomyosarcoma, and anaplastic epidermoid carcinoma. The course may seem rather benign at first but in many cases there is rapid invasion of the ethmoid labyrinth and the orbit, with subsequent exophthalmos and ophthalmoplegia.

Five roentgenograms; 5 photomicrographs.

**Treatment of Hemangioma of Infants and Young Children.** Robert J. Reeves. *Texas State J. Med.* **54**: 836-839, December 1958. (Duke University School of Medicine, Durham, N.C.)

The author reports his experience in treating 400 cases of hemangioma of the skin which have been satisfactorily followed. Most of the lesions were of the cavernous or strawberry type.

The sites of predilection are the head and face, and 80 per cent of the cases were seen in the first year of life. Radium, roentgen irradiation, or both were used in this series, but in the last ten years treatment was limited to roentgen therapy at 100 kvp. The author reports satisfactory and fair results in over 90 per cent of the group. Results are considered satisfactory when the lesions disappear completely, leaving no scar or a very small one, or when they show a marked flattening, bleaching, or decrease in size and are considered to require no further treatment. A fair result consists in partial change in color, size, or thickness, with need of more treatment.

Although some hemangiomas disappear spontaneously, it is not possible to predict which will do so. The author advises treatment, but adds a warning against overtreatment. Lesions near the female infant breast or the male genitalia are preferably to be treated surgically. Complications of overtreatment are scarring, skin atrophy, and telangiectasia.

Five tables.

J. S. ARAJ, M.D.  
Toledo, Ohio

**Carcinoma of the Nasal Fossa.** Robert G. Parker. *Am. J. Roentgenol.* **80**: 766-774, November 1958. (1211 Marion St., Seattle 4, Wash.)

Between 1949 and 1954, 14 cases of carcinoma of the nasal fossa were seen at the Tumor Institute of the Swedish Hospital, Seattle, Wash. In addition, there were 6 cases of squamous-cell papilloma which had originally been diagnosed as carcinoma. Roentgen irradiation was the initial method of treatment in 12 of the 14 cases of carcinoma and in all the re-diagnosed cases of papilloma. In lesions of the anterior fossa, low- or medium-voltage therapy appears preferable; in posterior fossa lesions, especially with extension into the nasopharynx, the use of supervoltage is more advantageous. Obvious involvement of cartilage or bone prior to treatment is a contraindication to irradiation.

Of the 12 patients initially treated with roentgen rays, 2 died with metastases. One had a metastasis in the thigh when first seen but received roentgen therapy in an effort to control hemorrhage from the nasal fossa. Three months later, at the time of death, there were widespread metastases, including pulmonary lesions, and the primary tumor was not controlled. The second death occurred in a patient with uncontrolled homolat-

eral cervical lymph node metastases, twelve months after treatment of a moderately well differentiated carcinoma involving the lower septum and floor of the fossa and filling the anterior fossa. The primary lesion remained controlled until death.

In 2 patients there was local recurrence treated by minimal resection. The first, a 14-year-old female initially seen with extensive disease involving the entire fossa, was without evidence of tumor at the time of this report, fourteen months after resection and ninety-three months after diagnosis. The other, a 77-year-old female, had remained without clinical evidence of tumor for four and a half years after resection, or for nearly five and a half years after initial diagnosis.

Of the remaining 8 patients, 1 died of heart disease thirty months after treatment, with no evidence of tumor in the nasal fossa. Another died with a second primary malignant neoplasm of the bronchus, thirty-two months after treatment of the nasal fossa carcinoma. At autopsy there was no evidence of disease in the fossa. Six patients, followed for three and a half to ten years, showed no clinical evidence of tumor.

Of the 6 patients with squamous-cell papilloma originally treated as nasal fossa carcinoma, all were tumor-free four to eight and a half years after therapy.

In view of the favorable results following roentgen irradiation of malignant neoplasms of the nasal fossa, separation of these lesions from those arising in the paranasal sinuses is important for adequate evaluation of both entities.

Two photomicrographs; 10 photographs; 1 table.

**Radiation Therapy for Cancer of the Tonsil.** Glenn E. Sheline, Malcolm D. Jones, and Lewis F. Morrison. *Am. J. Roentgenol.* 80: 775-780, November 1958. (University of California Medical Center, San Francisco 22, Calif.)

A total of 82 patients with malignant lesions of the tonsil were treated at the University of California Hospitals between 1931 and June 30, 1956. Fifty-six of these had been followed at the time of this report, for five years or longer.

Treatment was primarily by x-irradiation administered either through external fields or through a combination of external fields and intraoral cones. The quality of the rays varied, depending upon the machines available. Tissue doses of up to 6,000 r (in 2 patients, 7,000 r) were employed. These were attained at a rate of 800 to 1,200 r (tissue), with five or six treatments a week.

Of 20 patients who received tissue doses of 4,000 r or less, none survived two years.

Sixteen patients were treated with a total tissue dose of 4,000 to 5,000 r. Of these, 1 was living without evidence of cancer at the end of two hundred and eleven months; 2 had no evidence of cancer at the time of death, with survivals of sixty-five and one hundred and one months; the remaining 13 died with cancer after intervals of up to fifty-four months. Of 36 patients who received tissue doses of 5,000 r or more, 7 were living without evidence of disease at the time of this report; 3 had survived beyond the five-year period. Six (4 of whom survived more than five years) died without evidence of cancer. Twenty-three were either living with disease or dead from carcinoma, with survival periods ranging up to fifty-eight months.

The overall five-year survival rate for all types of irradiation was 20 per cent. The five-year survival for

those treated by external roentgen therapy only was 13 per cent, while that for those treated by intraoral cone and external rays was 36 per cent. The difference in survival between these three groups probably cannot be attributed to the method of therapy, but rather to the fact that only the smallest lesions were selected for intraoral cone therapy, and the most advanced patients received only palliative x-irradiation. Palliation was often achieved in patients with incurable tonsillar malignancy.

The presence of metastases at the time of the initial visit reduced the five-year survival from 33 to 9 per cent.

The five-year survival rate was essentially the same for patients treated with 1,000-kv roentgen rays as for those treated with radiation of other qualities.

Four tables.

**Carcinoma of the Palatine Tonsil.** Paul W. Scanlon, Vernon R. Gee, John B. Erich, Henry L. Williams, and Lewis B. Woolner. *Am. J. Roentgenol.* 80: 781-786, November 1958. (Mayo Clinic, Rochester, Minn.)

Of 46 patients who were treated at the Mayo Clinic in the years 1945 through 1949 for carcinoma of the palatine tonsil, 20 survived five years for an absolute five-year survival rate of 43 per cent. Of the 13 patients alive at the time of the present study, 1 had survived more than five years, 1 more than six, 4 more than seven, 1 more than eight, 4 more than nine, and 2 more than ten years after therapy. The five-year survival rate was directly related to the stage of the disease at the time of initial treatment. It was 73 per cent for 11 Stage-I lesions, 40 per cent for 10 Stage-II lesions, and 32 per cent for 25 Stage-III lesions.

A five-year survival was obtained in 6 (86 per cent) of 7 patients with lymphoblastoma; in 2 (33 per cent) of 6 with transitional-cell epithelioma; in 8 (32 per cent) of 25 with squamous-cell carcinoma; in 1 of 3 with adenocarcinoma. There was 1 case each of adenoid cystic carcinoma (cylindroma) and *in situ* carcinoma, and in 1 case biopsy of the primary lesion was negative but regional lymph nodes showed carcinoma. All of these patients were alive after five years. Two patients with negative biopsy but clinical diagnosis of cancer failed to survive.

There was no uniform plan of therapy for carcinoma of the tonsil during the years under discussion and, because of the ancillary measures employed in most instances, it is extremely difficult to assess the real merit of any one method. Nineteen patients in the series underwent definitive surgical treatment of the primary lesion, 3 with no additional therapy, and 13 of these survived five years or more. Dissection of regional lymph nodes was attempted to some extent in 8; in 4 of the 5 who survived for five or more years there was no histologic evidence of metastatic involvement of the nodes when excised tissue was examined. Twenty patients received what today might be considered acceptable high-dose fractional roentgen therapy; 7 survived five or more years. Some form of interstitial therapy was given to 19 patients. While the exact doses could not be calculated, it is believed that 4,000 to 6,000 r was given in most cases, plus whatever external therapy was added afterward. Ten of this group survived five years. The abandoned erythema dose technique was employed in 16 cases, many times for palliative purposes only, with 50 per cent five-year survival.



It is felt that the results obtained attest either to the value of treating each patient on an individual basis rather than adhering to a set, standard policy of treatment for all, or to the existence of some as yet unrecognized vital factor in the management of cancer. Three tables.

**Radiation Therapy for Stoma Ulcer Occurring After Subtotal Gastrectomy.** Everett D. Kiefer and Magnus I. Smedal. *J.A.M.A.* 169: 447-451, Jan. 31, 1959. (605 Commonwealth Ave., Boston 15, Mass.)

A series of 23 patients were treated with super-voltage roentgen therapy for stomal ulcers following subtotal gastrectomy. In 15 a satisfactory result was obtained after one course of therapy; in 3 others good results followed a second or third course of irradiation. There were 3 failures, but in all of these supervision was inadequate and there was no opportunity to repeat therapy. Two patients died of intercurrent or unrelated disease.

The tissue dose was approximately 1,800 r (2 Mev) delivered to the stump of the resected stomach through a 10 X 10-cm. portal. If necessary, the dosage was repeated at six-month intervals without danger or untoward side-effects.

Surgical treatment of stomal ulcers is a serious undertaking and the results are not good. Furthermore, the occurrence of a stomal ulcer is an indication that the ulcer diathesis is so strong that there is a good likelihood that, unless sustained and complete achlorhydria can be achieved, there will be still another recurrence.

The use of radiation in these cases is based on the fact that by this means acid secretion is decreased. While such reduction in acidity is usually transient, observations in the present series appear to indicate that the recovery of acid-secreting power is less likely to occur following subtotal gastrectomy than when the intact stomach is irradiated. In any event, follow-up studies are indicated with examinations for recurrent ulcer or acid secretion. Further treatment should be instituted if either condition is found. There is evidence that, if achlorhydria persists for three years after treatment, no further ulceration is to be expected.

Two roentgenograms; 1 table.

PAUL MASSIK, M.D.  
Quincy, Mass.

**Carcinoma of the Sigmoid Colon: Report of Two Inoperable Cases with Favourable Results Five or More Years Following Radiation Therapy.** C. C. Wang, Ernest M. Daland, and Thomas Gephart. *J. Fac. Radiologists* 10: 50-53, January 1959. (Massachusetts General Hospital, Boston, Mass.)

Two cases of inoperable adenocarcinoma of the sigmoid colon that were treated with radiation are cited. Both patients have lived five years following treatment.

The first patient was a 24-year-old female with a large carcinoma of the colon fixed to the lateral abdominal wall and in contact with a purulent abscess cavity. Exploration was done but resection was not attempted. Treatment was by 2,000-kv roentgen irradiation, with a tumor dose of 5,500 r in seven weeks. Opposing portals in the left lower abdomen and inguinal areas received 200 r daily. Approximately three months after x-ray therapy, the patient again underwent surgery. Resection of the tumor and end-to-end anastomosis were done. Multiple histologic sections

demonstrated chronic inflammation; but no residual carcinoma.

The second patient, a 37-year-old male, had a Grade III adenocarcinoma of the sigmoid colon, with extensive pelvic involvement. He received supervoltage therapy to opposing abdominal fields for a dose of 3,500 r in four weeks (150 r per day). Five years later there was no evidence of recurrence.

These unusual results, the authors state, are to be explained on the basis of unanticipated radiosensitivity of the particular tumors treated. They call attention to the fact that both patients were relatively young and suggest the need of further investigation of the radiosensitivity of adenocarcinoma of the sigmoid in younger age groups. It is recommended that radiation treatment be given to patients with neoplasms of this type which are unresectable because of spread in the pelvis or bowel perforation with infection. Post-irradiation removal of residual tumor may become possible, with ultimate cure.

Five roentgenograms; 2 photomicrographs.

CAPT. ALLAN E. GREEN, JR., M.C.  
Lackland AFB, Texas

**Wilms Tumor: A Report of 71 Cases.** John K. Lattimer, Meyer M. Melicow, and Aurelio C. Uson. *J. Urol.* 80: 401-416, December 1958. (Babies Hospital, New York 32, N. Y.)

The authors have reviewed 71 cases (67 proved) of Wilms tumor from the files of the Pediatric Urological Service of the Squier Clinic and the Babies Hospital at the Columbia-Presbyterian Medical Center (New York) from 1895 through 1956. Of the 25 patients seen between 1895 and 1933, 2 survived, an overall survival rate of 9 per cent; of the 42 seen between 1934 and 1956, 16 survived, or 38 per cent (all proved cases). Particular attention is accorded to a review of the data from the cases seen from 1934 through 1956, the survivors of which have had adequate follow-up. Thirty-six of the 42 patients underwent nephrectomy, and of these, 44.4 per cent (16) are alive. The longest follow-up period was twenty-three years, while the shortest was two years. In this series, 85 per cent of the deaths following nephrectomy for Wilms tumor occurred within the first two years; the outlook for those patients who survived beyond two years thus appears to be favorable.

There were 25 females and 17 males in the group of 42 proved cases seen since 1934, ranging in age from four days to eight years. Thirty-five per cent of the number were less than two years old. Of those patients who underwent nephrectomy at less than two years of age, 73.3 per cent are alive, whereas of those operated on between three and nine years of age, 18.5 per cent are alive. The outcome therefore, is more favorable in those patients treated at the earlier age.

An abdominal mass was palpable in every patient, and in 60 per cent it was the presenting symptom. Vomiting, abdominal pain, fever, or hematuria occurred in some of the children. Hypertension was found in 60 per cent of those in whom the blood pressure was recorded. The urographic examination was the most important single procedure in confirming the clinical impression of Wilms tumor. Plain films of the abdomen and intravenous urograms were often inadequate for diagnosis in patients with very large or very small tumors; however, the retrograde examinations were diagnostic in all cases (10) in which they were done.



Prompt nephrectomy followed by immediate post-operative radiotherapy appeared to be the treatment of choice. This procedure was employed in 26 cases with a transabdominal approach in 24 patients and through the flank in 2. The overall survival rate was 35 per cent (11 patients). The majority of the children surviving were under two years of age and had relatively small and well encapsulated tumors. Pre-operative radiotherapy was administered to 5 patients, all but 1 of whom died. The survivor was a one-year-old boy in whom radiotherapy was discontinued at the end of seven days, at which time nephrectomy was performed, followed by radiotherapy. Nephrectomy alone was performed on 5 patients, and 4 of these are alive, twenty-three, seventeen, fifteen, and ten years afterward.

Unfavorable prognostic factors include: (a) age over two years at time of operation; (b) localization of tumor at the upper pole of the kidney; (c) a capsule torn or penetrated by tumor; (d) presence of invasion and/or metastases; (e) an erythrocyte sedimentation rate of over 35 mm. in the first hour. None of 11 patients with an erythrocyte sedimentation rate between 35 and 90 mm. in the first hour survived.

The histologic pattern apparently exerted no influence on the prognosis (20 of the tumors were predominantly carcinoma, 18 were carcinosarcoma, and 3 were predominantly sarcoma), although the patients whose tumors were of the sarcomatous pattern did unusually well.

It is concluded that a more favorable prognosis may be attained in patients with Wilms tumor by arriving at an earlier diagnosis, and that the latter may be obtained, not only by careful physical examination of the newborn child and subsequent periodic clinical check-ups, but also by thorough urological evaluation of any child with unexplained fever, pyuria, hematuria, or other urinary symptom.

Six roentgenograms; 6 photomicrographs; 4 photographs; 1 graph; 15 tables. H. W. SCOTT, M.D.  
University of Pennsylvania

**Neoplasms of the Female Urinary Bladder.** C. Bernard Brack, Robert E. L. Nesbitt, Jr., and Houston S. Everett. *J. Urol.* 80: 24-30, July 1958. (Johns Hopkins Hospital, Baltimore, Md.)

Neoplasms of the female bladder may be either primary or secondary. When the bladder tumor is secondary, the primary tumor is usually located in the cervix, but neoplasms of the gastrointestinal tract and ovary may also metastasize to the bladder. The great majority of primary bladder tumors are of epithelial origin and are either papillomas, benign or malignant, or carcinomas, epidermoid or papillary. Infiltrating tumors are staged according to the degree of infiltration. In Stage 0 only the mucosal epithelium is involved; in Stage A, there is infiltration also of the submucosa; in Stage B, of the muscle; in Stage C, of the muscle and fat; in Stage D, of the regional or distant lymph nodes.

The present report concerns a series of 96 patients seen in the urological division of the Department of Gynecology at Johns Hopkins Hospital from 1945 through 1954. The average age was 60.2 years, with the youngest twenty-four and the oldest eighty-two.

The most frequent symptom of bladder tumor is bleeding, which was present in 70 of the 96 cases reported. Symptoms of cystitis—namely, frequency,

urgency, and dysuria—usually appear later in the disease, when the tumor has become infected. Retention or incontinence may occur when the tumor is near the sphincter. The ureters may be obstructed, giving rise to painful hydronephrosis.

In recent years it has been the custom of the authors to treat Group 0 and A tumors by means of electro-surgical fulguration. Group A tumors of pathological grade greater than Grade I have usually been treated with implantation of radon seeds into the bladder wall following fulguration. Gold seeds of 1 mc are placed at a distance of 1 cm. from each other for a total calculated dosage of 7,000 r or more to the tumor. For tumors of Stage B<sub>1</sub> (infiltration not more than halfway through the bladder muscle), segmental resection has been done if feasible, and total cystectomy where necessary. A complete pelvic lymph node resection was not done in any of these cases, although isolated nodes were sometimes excised. Most cases treated by segmental resection or total cystectomy received postoperative deep x-ray therapy, at either 400 or 250 kvp. The tumor dose is not mentioned.

The radium-bearing cystoscope was used in 9 cases, in 2 containing one or two capsules of 100 mg. each, and in 7 carrying a capsule containing 1,000 mc of radon.

For the patients treated up to 1954 the salvage for the superficial tumors was 44.4 per cent; for the deep tumors, 12.1 per cent; and for all cases, 33.3 per cent. The five-year salvage (cases treated up to 1950) was 41 per cent for the superficial group, 4.7 per cent for the deep group, and 28.3 per cent for all cases. The best result was obtained in the group A tumors treated by means of interstitial implantation of radon seeds combined with electro-surgical resection or fulguration.

One figure; 6 tables. ALFRED O. MILLER, M.D.  
Louisville, Ky.

**Some Observations on the Treatment of Certain Radio-resistant Tumours.** G. E. Flatman. *J. Fac. Radiologists* 10: 21-26, January 1959. (Meyerstein Institute of Radiotherapy, Middlesex Hospital, London, England)

There is now considerable histologic, radiologic, and clinical evidence that some so-called radioresistant tumors can be effectively treated by irradiation. At Mount Vernon Hospital (London) it has been the practice for a number of years to treat many of these tumors either by conventional roentgen techniques or, more recently, by the 4-Mev linear accelerator or the 1,500-curie theratron cobalt unit. A case is accepted for treatment only (1) when experience has shown that, although technically operable, it is incurable by surgery alone, (2) when surgery is impossible on account of the size and/or situation of the tumor, or (3) when the disease is advanced but palliation is considered possible.

Seven cases are reported: 2 fibrosarcomas (of the antrum and of the thigh) 1 sacral chordoma, 2 sarcomas of bone; 1 chondrosarcoma of the buttock; and 1 adenocarcinoma of the cecum. All of these were successfully treated by irradiation alone or combined with surgery.

The author reiterates the value of palliative radiotherapy which can produce long periods of recovery and possibly cure. Because of small though significant variations in the cell architecture, it is sometimes impossible to correlate the microscopic appearance with the response to radiation.

Six roentgenograms; 10 photomicrographs; 5 photographs.  
LT. COL. H. N. STURTEVANT, M.C.  
Lakeland AFB, Texas

**Dose Distributions in Arc Therapy in the 200 to 250 kv Range: Systematic Measurements in Homogeneous Phantoms with the Beam Direction Perpendicular to the Oscillation Axis.** Olov Dahl and Karl Johan Vikterlöf. *Acta radiol. Suppl.* 171, 1958. (In English and German) (Karolinska Sjukhuset, Stockholm 60, Sweden)

The purpose of this report on arc therapy was to communicate the results of a series of dose distribution measurements. These were conducted in radiophysiologically "water-equivalent" phantoms with the beam directed perpendicular to the oscillation axis. The investigation was carried out at the Radiumhemmet and Institute of Radiophysics (Stockholm). The present monograph consists of a large number of isodose charts along with tables of measurements and explanatory text in both English and German.

The apparatus employed in this project was a Siemens-Reiniger-Werke arc therapy unit fitted with an oil-immersed SKW 220/20 roentgen tube and operated at a constant potential of 200 kv. Added filtration of 0.5 mm. Cu + 1 mm. Al corresponded to a radiation quality of 1.1 mm. Cu h.v.l. It was shown, however, that the isodose charts, except for the dose rate factors given, would be largely valid for corresponding arc therapy with radiation qualities within the range of 0.7 to 2.0 mm. Cu h.v.l. The charts are also valid, on the whole, for nominal focus-surface distances between 40 and 60 cm. and nominal surface field lengths above 5 cm.

The measuring equipment consisted of 20 uniformly designed condenser chambers of the Sievert type, together with a Philips universal dosimeter. These microchambers, only 20 mm. in length and not more than 5 mm. in diameter, were subjected to extensive control tests for roentgen constants, energy dependence, dose linearity, and direction dependence and proved to meet the requirements for radiation detectors suitable in comprehensive dose distribution studies.

The principal variables in the treatment conditions were assumed to be the oscillation angle, the centering depth, and the width and length of the nominal surface field. The intervals chosen for each variable were 40° (60°, 100°, etc.), 2.5 cm. (0, 2.5, etc.), 1.0 cm. (2.0, 3.0, etc.) and 3.0 cm. (5.0, 8.0, etc.), respectively.

The dose distributions were investigated in 2 planes through the nominal entrance point perpendicular to each other, namely, the oscillation plane and the plane of symmetry. In the oscillation plane, 402 distributions in 7 different models were measured, with different combinations of oscillation angle, centering depth, and field width. In the plane of symmetry, on the other hand, it was considered that the main clinical interest was to establish the influence of the different variables on the extension parallel with the oscillation axis of the isodose contours with the highest relative dose values. In so doing, it was found that a correlation between the nominal surface field length and the extension parallel with the oscillation axis of, for example, the 75 or 90 per cent isodose contours, could be represented diagrammatically by a straight line. In fact, this relation may be employed with satisfactory accuracy for practical use in combination with any of the isodose charts in the oscillation plane presented,

and so give an idea of the corresponding 3-dimensional dose distributions.

The great majority of the measurements were made with the model positioned symmetrically in relation to both the oscillation plane and the plane of symmetry of the oscillation and with its axis parallel to the oscillation axis. To investigate the influence upon the dose distribution of asymmetry of the phantom in relation to the plane of symmetry of the oscillation, a series of measurements with an asymmetry of 5 and 10 cm. were made.

The selection of charts for publication was based, so far as possible, on the considerations arising in the treatment of tumors of varying size and at varying depths in different parts of the human body. The charts selected from each phantom were arranged with respect to the approximate depth of the maximum dose and to the approximate size of the area within the 90 per cent isodose contour, this arrangement implying progressively larger and deeper 90 per cent isodose areas.

Some charts were selected chiefly for the purpose of illustrating the influence of the phantom dimensions and each of the variables upon the dose distribution in the oscillation plane.

Six photographs; 170 dosage charts; 33 graphs and diagrams; 9 tables.

**Radiation Dosimetry by Transparent Plastics.** J. W. Boag, G. W. Dolphin, and J. Rotblat. *Radiation Res.* 9: 589-610, December 1958. (J. W. B., Mt. Vernon Hospital, Middlesex, England)

In experimental work with pulsed electron and x-ray beams, ionization methods of dosimetry may become impossible if the dose per pulse is so large that only a small fraction of the ionization can be collected. Calorimetry is probably the best method for large pulse doses, but the apparatus required is usually bulky, and the necessary precautions in its use are somewhat elaborate. The measurement of dose by the amount of chemical change produced in a system such as ferrous sulfate is still useful even at the high dose rates obtainable from a linear electron accelerator, but it is sometimes inconvenient to handle solutions that require an extreme degree of chemical cleanliness. The ultraviolet absorption induced in transparent materials by irradiation as a method of dosimetry has been proposed by Day and Stein (*Nature* 168: 644, 1951). The present paper deals with more detailed studies of this method, which is convenient for doses greater than about  $10^6$  rads.

The radiation-induced ultraviolet absorption in transparent plastics was investigated in detail and found to be a convenient, rapid, inexpensive, and accurate means of measuring radiation doses between  $10^6$  and  $2 \times 10^8$  rads.

In methyl methacrylate (Perspex) the change in optical density at 2,920 Å. is a linear function of the dose, up to about 3 megarads, and of the inverse of the thickness of the sample. Various factors that may influence the reproducibility of results were studied. The calibration curve, relating the change in optical density to the dose in rads, measured calorimetrically, is given.

In polyethylene terephthalate (Melinex), which can be obtained in thin foils, the induced absorption was measured at 3,250 Å. and the calibration curves obtained up to 200 megarads. The rate of fading of the

induced absorption and its bearing on the results are discussed.

Some examples are mentioned of the application of this technic to dosimetry.

Eighteen figures; 3 tables.

**Investigations of High Energy Electron Beams for Use in Therapy.** G. W. Dolphin, N. H. Gale, and A. L. Bradshaw. *Brit. J. Radiol.* **32**: 13-17, January 1959. (St. Bartholomew's Hospital Medical College, London, E. C. 1, England)

The electron beam spectra from a 15 Mev linear accelerator were obtained with a magnetic analyser. For quarter full-beam power the peak was 14.2 Mev and half-width 0.45 Mev, becoming 13.2 Mev and 0.75 Mev, respectively, for full beam power. A beam current of 30  $\mu$ A could be obtained, which gives a dose of  $2 \times 10^6$  rads per minute in a water phantom at 1 m. from the exit window.

In order to increase the cross-section of the 8-mm. diameter electron beam, a 0.66 mm. thick gold scatterer was placed in the beam. This caused a shift of 1.25 Mev in the peak of the energy spectrum, and gave a field 18 cm. in diameter for 90 per cent of the maximum dose. It is found that the half-width of the electron beam is proportional to the atomic number of the scattering material for a constant surface density, in the range from 0.1 to 0.75 gm./cm.<sup>2</sup>.

Central axis depth dose measurements are in agreement with similar curves published by others, except that the low surface dose was found only when mixed x-ray and electron beams were used. The curve varies with field area when the field diameter is less than twice the electron range in water.

The energy spectrum of the forward-moving electrons was measured for electron beams which had passed through 0, 1, 2, and 3 cm. of water. These show that

the energy spread increases, as the peak decreases, with depth.

Measurements were made in Perspex, using the optical density change at 2920 Å.

Nine figures.

LUCILLE DU SAULT  
The Henry Ford Hospital

**A Method for Construction of Isodose Charts from Minimum Experimental Data.** E. Ann Evans. *Am. J. Roentgenol.* **81**: 24-29, January 1959. (Peter MacCallum Clinic, Melbourne, Australia)

A method is described which permits rapid construction of isodose curves from a small number of measurements and reading of information from graphical data. The system may be adapted to any quality of radiation.

Three central-plane isodose curves, namely 5 X 5 cm., 10 X 10 cm., and 15 X 15 cm. at 55 cm. source-skin distance were measured in a water phantom. The distances from the central axis, at which particular depth dose values occurred, were read from these distributions at various depths and the values plotted against the square field axis size. Further points may be obtained by plotting from the measured distributions the distance from the central axis over which the isodose curves remain parallel to the incident surface. Graphs are made (and illustrated) which are referred to as "square field isodose crossplots for 55 cm. source-skin distance." Together with the F-factor (Mayneord and Lamerton: *Brit. J. Radiol.* **14**: 255, 1941) and data from the *British Journal of Radiology Supplement Number 5*, complete isodose curves for any set of conditions may be constructed. The steps in making these calculations are described for square fields, elongated fields, and fields of other shapes. The reader is referred to the original article for details of these calculations.

Nine graphs; 1 chart. JOHN W. WILSON, M.D.  
Johnstown, Penna.

## RADIOISOTOPES

**Radioiodine Tracer Tests in the Diagnosis of Hyperthyroidism.** K. H. Clarke, Keith D. Fairley, W. E. King, and Jean Milne. *Brit. M. J.* **2**: 1444-1446, Dec. 13, 1958. (Royal Melbourne Hospital, Melbourne, Australia)

In the selection of the most suitable radioiodine tracer test for routine use in diagnosis of thyroid dysfunction, consideration must be given to several factors including the reliability and simplicity of the test itself, as well as the demands imposed on hospital personnel and patient. In addition, the test must be reasonably reliable in the differentiation of clinically borderline cases. With these goals in mind the authors review the multiple radioiodine diagnostic studies now available and investigate three of them in some detail. For the purposes of this study 100 clinically borderline cases of hyperthyroidism in which no influencing pre-test medications had been given were evaluated by the following simple radioiodine tests:

1. *Two-hour uptake of radioiodine by the thyroid.*

2. *Two-hour neck-thigh ratio.* The relative counting rate of the neck, including concentration by the thyroid, is divided by the counting rate for the thigh. This test gives a measure of the speed with which iodine is cleared from the blood by the thyroid. The resulting value is considered to be a measure of the ratio between the iodine content of the tissue of the neck

including the thyroid gland and the iodine content of a similar volume of "indifferent tissue" of the thigh.

3. *Forty-eight-hour protein-bound radioactive iodine level*, expressed as percentage of ingested dose per liter of plasma.

All three tests were performed following an oral dose of 20 microcuries of I<sup>131</sup> on a fasting stomach. Results are tabulated. In summary, the three tests demonstrated the following results:

*Forty-eight-hour PBI<sup>131</sup> test:* Eighty per cent of cases where the result is over 0.50 per cent dose per liter are hyperthyroid; 95 per cent of the cases where the result is less than 0.45 per cent dose per liter are euthyroid.

*Two-hour neck-thigh ratio:* Eighty-five per cent of the cases where the result is over 50 are hyperthyroid; 90 per cent of the cases where the result is under 35 are euthyroid.

*Two-hour thyroid uptake:* Eighty-five per cent of cases where the result is over 55 per cent are hyperthyroid; 85 per cent of cases where results are under 50 per cent are euthyroid.

The authors feel that this type of reporting of results allows a rapid and simple evaluation of the limitations of each of the three tests. The tests can be easily performed, with a minimum of time expenditure by either the patient or hospital personnel.

The commonly used 24-hour thyroid retention test following an oral dose of  $I^{131}$ , the most widely used thyroid function test, has not been found particularly accurate or reliable by the authors. They have employed this test primarily as a useful measure of the degree of retention of radioiodine by the gland, a facet of information to be considered when assessing therapeutic dose of radioiodine required for treatment of thyrotoxicosis.

It is stressed that the tests reported here have been applied to clinically borderline cases, the type in which the physician is most likely to need laboratory aid in arriving at proper diagnosis. Classification of the diagnostic results in the series has been based on clinical evaluation of patients including follow-up studies and response to specific medication.

Four tables. JAMES W. BARBER, M.D.  
Cheyenne, Wyo.

**The Plasma Protein-Thyroid Hormone Complex in Man. III. Further Studies on the Use of the *in Vitro* Red Blood Cell Uptake of  $I^{131}$ -L-Triiodothyronine as a Diagnostic Test of Thyroid Function.** Milton W. Hamolsky, Arnold Golodetz, and A. Stone Freedberg. *J. Clin. Endocrinol.* 19: 103-116, January 1959. (Harvard Medical School, Boston, Mass.)

A report is presented, based on a four-year study of over 2,900 observations of the use of *in vitro* incorporation by red blood cells of  $I^{131}$ -L-triiodothyronine (TRI) from whole blood as an index of the status of thyroid function in man.

The percentage per hundred hematocrit for a two-hour incubation period, was the expression used to designate the  $I^{131}$ -L-triiodothyronine uptake. Correction was made of various hematocrits to 100. Consistent results were found in hematocrits of a 30 to 55 range. Variable results were achieved outside this range, to which they were corrected by the removal or addition of appropriate aliquots of the donor's plasma prior to the addition of  $I^{131}$ -TRI and incubation. In 1,301 of 1,353 females considered euthyroid, the two-hour red blood cell  $I^{131}$ -TRI uptakes ranged from 11.0 to 17.0 per cent, average 13.9 per cent; 0.2 per cent of these females had an uptake below 11.0, and 3.6 per cent had an uptake greater than 17.0 per cent. In 211 females considered hyperthyroid, uptakes ranged from 17.0 to 35.0 per cent, averaging 22.5 per cent. In 129 females considered hypothyroid, uptakes ranged from 6.1 to 11.0 per cent, averaging 9.3 per cent. In 566 males considered euthyroid the range was from 11.8 to 19.0 per cent, average 15.2 per cent. In 64 males considered hyperthyroid the uptakes ranged from 19.5 to 37.9 per cent, with an average of 23.7 per cent. In 65 males considered hypothyroid the range was from 5.5 to 11.6 per cent, average 9.7 per cent. The statistical validity of the suggestively higher values in males has not yet been determined.

The results indicate that this is a simple and rapid test possessing a diagnostic accuracy comparable to other standard methods of determining thyroid function. The evaluation of thyroid function under circumstances in which other standard methods may not be applicable, particularly after the administration of organic iodine-containing compounds, is permissible by this means. It has been found useful in following the course of therapy for hyper- and hypothyroidism. Decrease in the uptake has been found in normal pregnancies and after administration of estrogen. In six

pregnancies the red cell uptake was found to be in the normal euthyroid range beyond the eighth week of gestation, and each of these pregnancies subsequently terminated in miscarriage.

The uptake was seen to be increased in nephrosis, in certain cases of liver disease and metastatic cancer, in pulmonary insufficiency with  $CO_2$  retention, in paroxysmal atrial arrhythmias, and following the administration of anticoagulants. It was decreased following the administration of propylthiouracil and of iodides in hyperthyroidism. It is believed that this method is a practical and useful additional parameter in the study of thyroid physiology and disease.

Two charts; 4 tables. W. J. VARLEY, M.D.  
Mercy Hospital, Pittsburgh

**Thyroid Function in Supraventricular Tachycardias: Turnover of Intravenously Infused  $I^{131}$ -Labeled Thyroxine and the Red Blood Cell Uptake of  $I^{131}$ -Labeled L-Triiodothyronine.** George S. Kurland, Arnold Golodetz, Milton W. Hamolsky, and A. Stone Freedberg. *J. Clin. Endocrinol.* 19: 92-102, January 1959. (Harvard Medical School, Boston, Mass.)

Thyroid function was studied in 39 patients with supraventricular arrhythmias. All 39 patients were judged to be euthyroid at the time of final evaluation after consideration of the clinical picture and appropriate laboratory tests. In 28 of the series there was paroxysmal or recent prolonged atrial fibrillation and 11 patients had paroxysmal atrial tachycardia.

In 11 cases, the fate of intravenously administered  $I^{131}$ -thyroxine was studied. The half-time of disappearance of plasma radioactivity ranged from 4.1 to 6.8 days and averaged 5.7 days. In previously reported series of normal subjects, the range was from 6.6 to 7.8 days and averaged 7.2 days. The mean daily proportion of thyroxine turned over in the patients with arrhythmia was 12.2 per cent, and in the normal subjects 9.7 per cent. The thyroxine distribution space in the patients with tachycardia ranged from 8.0 to 16.4 liters (average, 12.2 liters) in contrast to a range of 7 to 12 liters (average 9.9 liters) in the control group. The daily thyroxine degradation varied from 52 to 126 micrograms per day (average 83.6) in the group under study, but was only 36 to 61 micrograms (average 50.9) in the controls.

The two-hour *in vitro* red blood cell uptake of  $I^{131}$ -triiodothyronine from the whole blood in the entire series of 39 patients averaged 17.5 per cent per hundred hematocrit. In 18 male patients the average uptake was 18.6 per cent per hundred hematocrit, the average value for euthyroid male subjects being 15.2 per cent. In 8 of the 18 male patients with arrhythmias although euthyroid, the red blood cell uptake was greater than 19.5 per cent, a value often associated with thyrotoxicosis. Twenty-one females with atrial fibrillation and atrial tachycardia averaged 16.5 per cent per hundred hematocrit uptake in contrast to an average in normal females of 13.9 per cent. Seven of the 21 had uptakes above 18 per cent, considered to be the upper limit for euthyroid females. No relationship was determined between the red cell uptake of  $I^{131}$ -triiodothyronine and the rate of turnover of  $I^{131}$ -thyroxine.

Treatment with large doses of potassium iodide, despite the fact that the patients were considered euthyroid, caused improvement of the arrhythmias in 5 patients. The conclusion is reached that a variety of clinical and experimental data indicate an important



role for thyroxine in the control of cardiac action and suggest possible mechanisms by which even small changes in the amount of thyroid hormone available to the tissues may increase cardiac metabolism and irritability and produce fibrillation or tachycardia without inducing the classic manifestations of hyperthyroidism.

One chart; 2 tables.

W. J. VARLEY, M.D.  
Mercy Hospital, Pittsburgh

**The Significance of the Protein-Bound Radioactive Iodine Determination in Hyperthyroidism.** J. S. Staffurth and I. Birchall. *Acta endocrinol.* 30: 42-52, January 1959. (J. S. S., Lewisham Hospital, London, S.E. 13, England)

The diagnostic value and the significance of the plasma-bound radioactive iodine (PBI<sup>131</sup>) were assessed in various thyroid disorders and compared with the 24-hour thyroid uptake. The investigation covered all patients seen at the Radioactive Isotope Laboratory, St. Thomas's Hospital, London, between January 1956 and June 1957 on whom radioactive iodine studies were complete. The final diagnosis was based on the clinical state, the results of other examinations, and on the outcome of treatment, particularly in those patients in whom unexpected or equivocal results were obtained. One hundred and eighty-eight patients were investigated in relation to primary hyperthyroidism, 36 after partial thyroidectomy, 21 after I<sup>131</sup> treatment for hyperthyroidism, 3 after treatment with methyl thiouracil, and 73 with nodular goiter.

The PBI<sup>131</sup> test was found of great assistance in the diagnosis of untreated primary hyperthyroidism. It is of less help in the diagnosis of recurrent or persistent hyperthyroidism after surgery or radioiodine treatment, as the PBI<sup>131</sup> may be raised in the euthyroid state due to a reduction of the intrathyroidal organic iodine pool.

PBI<sup>131</sup> is of some assistance in the investigation of toxic nodular goiter, but a normal value may be obtained in the presence of hyperthyroidism. The figure may be elevated in mild hypothyroidism, lymphadenoid goiter, iodine deficiency, nephrosis, and familial cretinism.

The 24-hour-thyroid uptake, by itself, is an unreliable index of thyroid function. When it is combined with the PBI<sup>131</sup> determination, an accurate diagnosis can be made in relation to primary hyperthyroidism.

Four figures; 3 tables.

**Carcinoma of the Lingual Thyroid Treated with Radioactive Iodine.** W. A. Mill, N. F. C. Gowing, Brian Reeves, and D. W. Smithers. *Lancet* 1: 76-79, Jan. 10, 1959. (Royal Marsden Hospital, London, S. W. 3, England)

The authors report a case of lingual thyroid tumor in a young woman. The tumor appeared during two successive pregnancies and enlarged rapidly after the termination of the second. No evidence of malignancy was found in a biopsy specimen removed by diathermy during the first pregnancy, but a second biopsy, during the eighth month of the second pregnancy, showed "recurrent neoplasm of lingual thyroid, now certainly malignant." Cesarean section and sterilization were performed. A tracer dose of I<sup>131</sup> concentrated in the tumor, and treatment with radioiodine (161 mc) was therefore carried out. This resulted in rapid regression of the tumor, and no signs of recurrence were observed during a follow-up of almost two years.

The few previously recorded cases of lingual thyroid carcinoma are reviewed, and the relatively favorable prognosis for this tumor in women is again emphasized.

Six illustrations, including 1 roentgenogram; 1 table.

**Acute Granulocytic Leukemia After Radioactive-Iodine Therapy for Hyperthyroidism.** William M. Kennedy and Robert G. Fish. *New England J. Med.* 260: 76-77, Jan. 8, 1959. (Oteen, N. C.)

The authors describe a case of acute granulocytic leukemia occurring twenty-two and a half months after the administration of 5.5 millicuries of I<sup>131</sup> for hyperthyroidism. Five other cases of acute leukemia after radioactive iodine therapy have been reported. The figures are too small to be statistically significant, but the authors suggest that there may be more than a chance relationship between acute leukemia and the use of radioactive iodine in hyperthyroidism. Of the 5 cases previously reported, 3 were of granulocytic origin, 1 lymphoblastic, and the fifth probably monocytic.

PAUL MASSIK, M.D.  
Quincy, Mass.

**Occurrence of Thyroid Nodules in Children Following Therapy with Radioiodine for Hyperthyroidism.** Glenn E. Sheline, Stuart Lindsay, and H. Glenn Bell. *J. Clin. Endocrinol.* 19: 127-137, January 1959. (University of California School of Medicine, San Francisco, Calif.)

In 2 out of 5 patients treated with I<sup>131</sup> for diffuse toxic goiter at the University of California Hospital before the age of ten, thyroid nodules developed after eight and ten years respectively. The evidence suggested that these were true neoplasms. In 1 of 13 patients between the ages of ten and twenty, thyroid nodules developed five and a half years after therapy. In patients over the age of twenty, the incidence was 2 out of 195 within two years of therapy. All patients became euthyroid following treatment.

It is emphasized that nodular hyperplasia of the thyroid may occur if functional thyroid tissue is left in children treated with I<sup>131</sup>. In patients less than twenty years of age, preference should be given to other forms of treatment. If special circumstances make this the treatment of choice, sufficiently large doses should be given to produce hypothyroidism, thereby preventing a subsequent diffuse nodular hyperplasia.

Seven photomicrographs; 1 table.

ZOLTAN SZALONTAY, M.D.  
Mercy Hospital, Pittsburgh

**Present Status of Radioactive Gold Therapy in Management of Prostatic Cancer.** R. H. Flocks, D. A. Culp, and H. B. Elkins. *J. Urol.* 81: 178-184, January 1959. (College of Medicine, University of Iowa, Iowa City, Iowa)

The authors report a series of 911 cases of prostatic carcinoma, which they divided into three groups. In Group 1, consisting of 27 patients, the tumor was limited to the prostate and treatment was by total prostatectomy. In Group 2, numbering 517 patients, the disease was locally inoperable but with no evidence of remote metastasis. Group 3 was made up of 367 patients in poor general condition, over seventy-five years of age, or with distant metastatic deposits.

The patients in Group 2 were treated with interstitial injections of radioactive gold, 1.5 mc/gm. of tissue com-



combined with 100 turbidity units of hyaluronidase. The concentration was 12 to 25 millicuries per cubic centimeter of solution, and an average total volume of 4 to 6 c.c. was used. This small volume was felt to be important in order to obviate widespread diffusion of the particles. Five operative approaches were utilized: retropubic, transvesical, perineal, open perineal, and transrectal. The authors felt that the procedure could be repeated after an interval of two months and recommended either a perineal or transrectal route at that time. If the areolar tissue and lymphatics were to be directly injected, a concentration of 3 mc/c.c. and a total of 10 c.c. were recommended. For the pedicle area, 0.5 to 1.0 c.c. with 15 mc/c.c. concentration was utilized.

Each lesion was considered to have four compartments: (1) within the genital fascial envelope; (2) within the periprosthetic, perivesicular, and perivesical areas and along the vesicular pedicle; (3) within the pelvic nodes; (4) within the lymph channels. Each compartment was injected with the isotope, and ten days later a transurethral resection of the internal portion of the gland was done. Secondary and tertiary injections were utilized for lesions not responding to the initial treatment. This type of therapy was found to be most efficacious in small glands.

For larger glands a total prostatectomy was preferred, followed by injection of radioactive gold into the periprosthetic pedicle and lymphatic areas. The results with this procedure were found to be better than with radiation and transurethral resection alone.

Injection of the isotope into grossly involved nodes was not effective, nor did injection of gold into the prostate appear to produce radiation of the nodes. Therefore, with node involvement surgical dissection of a discontinuous type was done, followed by injection of the remaining areolar tissue.

The authors recorded only 4 deaths in 785 procedures performed on 517 patients, and none of these was felt to be secondary to radiation. The five-year survival figure was 42 per cent, compared to 30 per cent for a group treated palliatively.

One radioautograph; 3 photomicrographs; 3 photographs; 4 drawings; 4 tables.

MARK MISHKIN, M.D.  
University of Pennsylvania

**External Recording Method for Estimating Hepatic Blood Flow with the Use of Radiogold.** Joseph S. Burkle and Marvin L. Gliedman. *Gastroenterology* 36: 112-119, January 1959. (United States Naval Hospital, St. Albans, N. Y.)

The flow of blood through the liver has been estimated in man by Bromsulphalein, urea production, rose bengal, and the colloidal particle extraction technic in which chromic phosphate or radiogold is used. This last method depends on the extraction of colloid particles, such as gold, from the blood by the liver and spleen reticuloendothelial system. It formerly entailed the taking of frequent blood samples after  $\text{Au}^{198}$  administration. The present study was undertaken to determine the accuracy of a percutaneous method of counting to estimate hepatic blood flow, instead of repeated blood sample counts.

Control studies were performed on dogs and on patients, whereby blood samples were frequently withdrawn and continuous percutaneous counts were simultaneously obtained over a large blood vessel. From

these studies the disappearance curve of radiogold from the blood was determined.

"The halftime of the disappearance from the blood of the colloidal gold, or  $t_{1/2}$ , was determined by plotting the logarithm of activity against time and measuring off the time required to reach half of the original activity. The slope of the curve was calculated by the formula  $K = 0.693/t_{1/2}$ , where  $t_{1/2}$  was in minutes and  $K$  was in minutes<sup>-1</sup> (Dobson *et al.*: *Circulation* 7: 690, 1953). Since the slope of the disappearance curve is the fraction of gold that is removed per unit of time, and since the colloidal particles are removed in over 90 per cent of the total amount by the liver and spleen, then  $K$  is the fraction of blood volume that is flowing to the liver. Therefore, the product of the blood volume and  $K$  is the hepatic blood flow or estimated hepatic blood flow."

From these animal studies and observations on normal men and patients with hepatitis and cirrhosis the authors conclude that the percutaneous method is satisfactory for measurements of hepatic blood flow.

Two illustrations; 8 tables. J. S. ARAJ, M.D.  
Toledo, Ohio

**Physical and Clinical Advantages and Limitations of Cobalt 60 Teletherapy. Part I. Physical Factors.** Carl B. Braestrup. *Am. J. Roentgenol.* 81: 13-18, January 1959. (630 W. 168th St., New York, N. Y.)

The level of maximum dose with cobalt-60 teletherapy occurs about 0.5 cm. below the skin; with 250 kv the maximum ionization is at the surface or in the cutaneous tissue. This advantage of cobalt 60 is achieved only if there is no significant electron contamination of the beam, and this may be accomplished either by utilizing adequate distance (about 15 cm. between beam collimator and skin) or by the use of electron filters such as brass. Plastic-bottomed cones close to the patient will cause the maximum ionization to occur in the skin and should not be used when skin-sparing effect is important.

Another advantage of cobalt-60 teletherapy is the higher depth doses achieved by this method of treatment. The exit dose is also higher, which must be taken into consideration when opposing fields are used. One of the principal advantages of cobalt-60 teletherapy is the reduced integral dose. The relatively lower absorption in bone, as compared with soft tissues, for cobalt 60 is well established. The output is nonfluctuating and a fairly homogeneous gamma radiation is delivered. These factors permit more accurate radiation measurements and dose determinations. All of these factors are listed in contradistinction to roentgen-ray equipment in the usual voltage range.

In the past, there have been two principal limitations of cobalt-60 teletherapy: penumbra and low radiation output. Penumbra can be reduced by decreasing the size of the source or by increasing the source-tumor distance and retaining the same collimator-tumor distance. With a greater distance, however, it is necessary to use a larger source to maintain the same dose rate. The question naturally arises whether elimination of a penumbra of a few millimeters is worth the additional expense and the increased weight of the equipment necessary to house a larger source.

In most cases, reduction of the geometric penumbra below 1 or 2 cm. is justified only if the extent of the lesion is known within these limits. A penumbra of that magnitude does not add significantly to the inte-

gral dose. There is also a transmission penumbra due to the incomplete attenuation of rays by the edges of the collimating system. The transmission penumbra is reduced by constructing the diaphragms of material of high atomic number and having the leading edges of the diaphragms directed to the edge of the source.

Replacement costs of the cobalt-60 source usually exceed the maintenance expense of roentgen-ray equipment, and the initial cost and size of the cobalt-60 teletherapy unit are greater than of the 250-kv roentgen-ray apparatus. Perhaps of even greater economic significance are the room-shielding requirements. For example, the primary concrete shielding may need to be over twice as thick as for 250 kv.

Three figures; 3 graphs; 2 tables.

JOHN W. WILSON, M.D.  
Johnstown, Penna.

**Physical and Clinical Advantages and Limitations of Cobalt 60 Teletherapy. Part II. Clinical Considerations.** Ruth J. Guttman. *Am. J. Roentgenol.* 81: 19-23, January 1959. (Frances Delafield Hospital, New York 32, N. Y.)

The advantages of supervoltage therapy have been well established for the treatment of deep-seated lesions and of extensive disease where large volumes require irradiation. The author points out, however, that different cobalt models are not necessarily alike in performance. To illustrate this, she assumes conditions in which 5,000 r must be delivered in five weeks through fields of  $5 \times 5$  cm.,  $12 \times 12$  cm., and  $15 \times 15$  cm. to lesions of the neck, thorax, and pelvis.

In the neck, where the tumor is situated only 5 cm. below the surface, it can be shown that the desired depth dose can be delivered through a 250-kv unit with a skin dose of 5,400 r, as compared to a skin dose (0.5 cm. below the surface at the point of maximum ionization) of 5,600 r for a cobalt-60 unit. With the 250-kv unit, a point 1 cm. outside the  $5 \times 5$ -cm. field receives 25 r for 100 r delivered to the center of the tumor with a 50-cm. target-skin distance. With the cobalt-60 source operating at 25 cm. source-skin distance, the dose is 90 r for 100 r delivered at the center of the tumor. Therefore, in delivering a total tumor dose of 5,000 r, the depth dose 1 cm. outside the field would equal 1,250 r with the 250 kv unit and 4,500 r for the cobalt-60 unit. This high reading is due to an increase in field size at the depth when short distances are employed with cobalt-60 sources. This effect is, of course, undesirable if neighboring anatomic structures are to be spared high quantities of radiation. It is imperative, therefore, to decrease the field size on the skin if treatment conditions as described above are employed. Source-tumor distances of 55 to 75 cm. result in no appreciable difference between the field size on the skin and at a depth of 5.0 cm. when cobalt-60 units are employed. Supervoltage therapy may be suggested for lesions close to the surface, however, since skin and cartilage tolerances are better.

In the case of thoracic lesions, an important consideration in dose determinations is the adjacent normal lung and mediastinal structures. Isodose curves must be applied since, with cobalt-60 units, the skin doses, central depth doses, and penumbra vary depending upon the distances employed and size of the source. In the thorax, marginal as well as central doses may be very important. The larger the source and the longer the distance, the larger the penumbra. Although the

center doses may vary little, the differences between skin doses and marginal doses may be greater.

In the external treatment of carcinoma of the cervix, the lateral pelvic walls must receive sufficient radiation. With cobalt-60 units the dose delivered on the lateral pelvic wall may be inadequate. This can be remedied by using full rotation. If shorter distances are employed, the disadvantage of increasing the field size at the depth ensues.

For each of these three therapeutic problems (neck, thorax, and pelvis), depth dose charts superimposed upon anatomic fields are shown with given treatment factors to demonstrate the variable dose results.

To obtain the best results with a cobalt-60 unit, one must have an exact knowledge of its inherent characteristics, and this can be appreciated only if isodose curves are used for treatment planning.

Six figures; 1 table.

JOHN W. WILSON, M.D.  
Johnstown, Penna.

**A Precision Cobalt 60 Unit for Fixed Field and Rotational Therapy.** H. E. Johns and J. R. Cunningham. *Am. J. Roentgenol.* 81: 4-12, January 1959. (Ontario Cancer Institute, Toronto, Ont., Canada)

Some cobalt-60 beam therapy units have a large penumbra. Penumbra may be minimized by reducing the size of the source or placing the diaphragm nearer to the skin surface or by a combination of these procedures. This article describes a cobalt-60 unit that was designed for fixed field and rotational therapy, in which an adequate source-to-tumor distance is maintained and the penumbra is kept small through the use of a special collimator. The unit is composed of a head containing the radiation source and a counterweight mounted on opposite ends of a hollow steel column which rotates about a horizontal axis. The counterweight acts as a radiation shield and houses a focusing ion chamber for transmission dose measurements. A roentgenographic tube is mounted in the head and connected to a 100-kv roentgen ray transformer in the column next to the counterweight.

For fixed field therapy the device is arranged to treat at 80 cm. and for rotational therapy the axis is placed at 93 cm. To overcome an impractical distance from floor to axis, the unit is arranged so that the head passes below the floor level when rotation occurs. Two trap doors move down when the system is set into rotation. Light-beam localizers are utilized.

The collimator is composed of heavy metal arcs, the leading edges of which are always on a straight line toward the edge of the source. The beam can be set to a maximum field of  $20 \times 20$  cm. and a minimum field of  $4 \times 4$  cm. at 80 cm. distance.

In the counterweight is a focusing lead plug, which removes most of the scatter radiation from the patient and allows the ion chamber to record only primary radiation from the source (attenuated by the patient). The response of the ion chamber is recorded on the control panel by a potentiometer.

Thirteen figures.

JOHN W. WILSON, M.D.  
Johnstown, Penna.

**Calorimetric Measurements on a Cesium-137 Teletherapy Unit.** Paul N. Goodwin. *Radiation Res.* 10: 6-12, January 1959. (Royal Cancer Hospital, London, England)

The conventional means of measuring the intensity of a beam of x- or  $\gamma$ -radiation has long been the meas-

urement of the ionization produced in air, as required when the roentgen is the unit of dose. But with the introduction, and recommended use, of the rad as the fundamental unit of absorbed dose, the direct measurement of energy absorption by calorimetric methods has become of interest. Among the first such measurements were those of Laughlin and his co-workers, who used calorimeters on a 22-Mev betatron, a 400-kev generator, and a  $\text{Co}^{60}$  unit (Am. J. Roentgenol. **70**: 294, 1953. Abst. in Radiology **63**: 309, 1954). Calorimetric measurements determine the intensity of an x- or  $\gamma$ -ray beam directly in ergs per square centimeter per second; and, together with suitable ionization measurements, yield the ergs per square centimeter per roentgen, and thus relate rads to roentgens at a particular quantum energy. This factor, the quantity of radiation per roentgen, was calculated over a wide range of energies by Mayneord (Brit. J. Radiol. Supp. 2, pp. 133-136, 1950). Its rapid variation with photon energy makes it essential to have measurements made at a number of different photon energies.

The author describes calorimetric measurements made on a 1,400-curie  $\text{Cs}^{137}$  teletherapy unit installed at the Downs branch of the Royal Marsden Hospital.  $\text{Cs}^{137}$  offers certain advantages over x-ray units for calorimetric measurements, such as constant output and a monochromatic primary beam (662 kev), but also some disadvantages, such as the low output (about 14 r/min.) at the minimum source-absorber distance (50 cm.) and large penumbra due to the large source diameter (2.7 cm.).

A comparison of the energy absorption measurements with corresponding ionization measurements gives the value for the conversion factor for 662 kev of  $2959 \pm 44$  ergs/cm.<sup>2</sup>/r, and combining this result with the calculated absorption coefficient gives a value for  $W$  of  $33.9 \pm 0.5$  ev/ion pair. [Laughlin *et al.* cited above, define  $W$  as the average energy expended by an electron per ion pair formed.—Ed.]

**Accumulation of Polonium ( $\text{Po}^{210}$ ) by Water-Living Organisms.** V. Z. Agranat. Med. radiol., Moscow **3**: 65-69, January-February 1958. (In Russian)

The bottom of water reservoirs accumulates a significant amount of polonium 210. The specific radioactivity of the bottom layers surpasses that of the water by thousands of times and may be the source of secondary water pollution. The polonium accumulation by flora and fauna of the water reservoir may reach considerable values, thousands and tens of thousands times higher than the radioactivity of the water itself. The polonium concentration in plankton and bottom-living organisms markedly surpasses that found in water plants and fish. However, the polonium accumulation in the fish of water reservoirs of even low radioactivity is still much higher than the upper limit of the permissible concentration ( $5 \cdot 10^{-11}$  curies per liter). Correction of our present concepts relative to permissible polonium concentrations in open water reservoirs is needed.

ERNST A. SCHMIDT, M.D.  
Gardena, Calif.

**Transmission of Radioactive Strontium through Food from Open Water Reservoirs into the Human Organism.** A. N. Marei, M. M. Saurov, and G. D. Lebedeva. Med. radiol., Moscow **3**: 69-76, January-February 1958. (In Russian)

During their life and growth in water containing

radioactive strontium, water-living plants and animals accumulate and concentrate a considerable amount of radioactive isotopes, especially radiostrontium, in their tissues. Fish, ducks, and other water-fowl are extensively consumed by man, to whom they may transmit radioisotopes. Plankton, water plants, mollusks, and other water-life which has no major links in the human nutrition chain, are of theoretical rather than practical interest. Most radioactive material is accumulated in bone tissue whence it enters broth and other liquid food in the process of cooking. Control not only of water reservoirs but also of food products possibly contaminated with radioactive isotopes appears advisable.

Two graphs; 8 tables. ERNST A. SCHMIDT, M.D.  
Gardena, Calif.

**Determination of Cardioportal Circulation Time by External Scintillation Counting.** Ismael Mena, Leslie R. Bennett, Raymond Kivel, Joseph Scallon, and Sherman M. Mellinkoff. Am. J. Digest. Dis. **4**: 19-28, January 1959. (University of California Medical Center, Los Angeles, Calif.)

A method is described for the determination of cardioportal circulation time by radioisotope techniques with external scintillation counting. Radioiodinated serum albumin in doses of 0.25 microcuries per kilogram body weight is injected rapidly into an antecubital vein. A collimated scintillation probe is placed over the precordium to determine the time of appearance of the radioactive bolus in the heart and the length of its stay there. A similar counter is placed over the liver, directed at the hepatic hilus. By a study of the curves of appearance times of the radioactive material and the period over which the activity remains, a reasonably reliable assessment of cardioportal circulation time can be made. In this study the cardioportal time is defined as the interval from the maximum measured radioactivity over the heart to the maximum activity of the portal curve measured over the liver.

Eighty-seven circulation times were determined for 85 patients and the results are summarized in a table. Thirty-six normal individuals showed cardioportal circulation times of about twenty-five seconds. Thirty-eight patients with cirrhosis of the liver were studied, including 7 following portacaval anastomosis. In general the shapes of the curves in the cirrhotic patients were no different from those in the controls but the cardioportal circulation time was greatly prolonged. In 26 patients with portal cirrhosis the mean time was 44.8 seconds and the standard deviation 5.1 seconds. In 3 additional patients with cirrhosis known to have partial portal venous obstruction due to thrombosis, the mean time was 55 seconds. In 2 cases of the Cruveilhier-Baumgarten syndrome the times were 19 and 24 seconds respectively. The 7 patients who had undergone portacaval anastomoses showed drastically changed hepatic activity curves with a short circulation time, averaging 18 seconds. Small numbers of patients with other liver diseases were studied. In 5 patients on whom portal vein pressures could be determined (at surgery) there was a good correlation between prolonged cardioportal circulation time and increased portal pressure.

This method may be a valuable aid to clinical diagnosis in selected cases.

One photograph; 4 graphs; 2 tables.

JAMES W. BARBER, M.D.  
Cheyenne, Wyo.

**Physiological Studies on Beriberi Heart Disease by Injection of Radioactive Material.** R. Lessard, J. P. Bernier, and Y. Morin. *Canad. M. A. J.* **80**: 112-114, January 15, 1959. (Hôtel-Dieu, Quebec, P. Q., Canada)

A high cardiac output appears to be a constant feature of the acute form of beriberi heart disease and it was felt that its determination by injection of radioactive material into the blood stream might be a useful emergency diagnostic procedure.

Continuous arterial blood sampling technic and body-surface counting with a scintillation detector following administration of radioiodine gave essentially the same results. With the aid of fluoroscopy, skin marks were made along an anteroposterior diameter passing through the aortic arch. The axis of the detector was adjusted along this line with an edge of the collimator touching the chest. About 100 microcuries of radioiodinated

human serum albumin in a volume of 1 c.c. was injected into an antecubital vein as rapidly as possible, the moment of injection being marked on the recording paper. In initial studies the injected radioiodinated human serum albumin was used to determine both the cardiac output and the blood volume. Following therapy, the volume was first measured by injecting a small quantity of tagged albumin thirty minutes before the cardiac output determination. The output in terms of blood volume per minute is a good indication of blood-mixing efficiency.

In thiamine lack, as seen in beriberi, there is a widespread dilatation of the arterioles and capillaries with an increased rate of blood flow. Using the cardiac output values found by injection of radioiodine, the total peripheral resistance was also calculated.

A case is reported in which this procedure was used before and after thiamine administration.

## RADIATION EFFECTS

### The Radiation Hazard as It Affects Medical Practice.

H. A. S. van den Brenk. *M. J. Australia* **2**: 316-319, Sept. 6, 1958. (Victoria, Australia)

Radiobiological theory supported by extensive experimental evidence points to a non-threshold, cumulative effect of ionizing radiations in genetic mutations in lower animals, and in certain somatic changes in simple living models (e.g., viruses). This conclusion is based on (i) the exponential shape of survival curves, (ii) the independence of the fractionation of a dose and the intensity of a given dose on effect, (iii) the influence of linear energy transfer or the ionization density of the radiation on the effect produced, and (iv) the effect of changes of temperature of the irradiation medium.

Mutations of individual genes occur spontaneously with a frequency of  $10^{-6}$  or  $10^{-4}$  per generation. They are induced by ionizing radiations at a rate greatly in excess of this. It is further pointed out that a given dose of radiation produces chromosome breaks more readily in the X chromosome than in the Y chromosome.

There is no evidence and little likelihood that radiation produces new types of genes. It may, however, increase the mutation rate of known traits, and this could favor survival in instances where the heterozygous state confers a selective advantage.

The British Medical Research Council Report, based on available experimental and human evidence, submits that a dose of 30 to 80 r to the gonads of fertile individuals spread over a thirty-year period causes a doubling in the mutation rate. This is compared with a lifetime exposure at present levels of radiation of 3 to 4 r, of which about 15 per cent (0.6 r) is due to the diagnostic use of x-rays, 75 per cent (3 r) to background radiation, and the rest to other causes. In this connection it is stated that only the gonad dose contribution of a diagnostic procedure carries genetic effects. There is no evidence available that extragonadal irradiation has an indirect mutagenic effect on the gonads. In Australia 67 per cent of diagnostic examinations involve lower extremities or structures above the diaphragm, but this bulk of diagnostic examinations contributes only 9.95 per cent of the total gonadal dose contribution from all diagnostic examinations. The major gonad dose contribution (99 per cent) arises from examinations of abdominal viscera, lumbar vertebra, pelvis, and hip bones.

The suggestion frequently made that the population be issued identity cards, requiring entry of radiological exposures, may be interesting for the collection of scientific data, but such a measure may attach a stigma to radiography which the uninformed individual is unable to assess logically and will deter early and accurate diagnosis of disease.

That ionizing radiations are leukemogenic is based on the increased incidence of leukemia in the Japanese atomic bomb casualties, in radiologists, in children subjected to pelvic diagnostic radiography *in utero*, and in cases of ankylosing spondylitis treated with x-rays. Added to this is the correlation of the increase in leukemia with increasing use of diagnostic radiology and radiation exposure from other sources, and a large body of experimental evidence.

A dose of 30 to 50 r administered to the whole marrow may reasonably be expected to double the incidence of leukemia in man. However, most radiographic and indeed radiotherapeutic procedures are regional. The author quotes Witts (*Brit. M. J.* **1**: 1197, 1957) as follows: "The possible 50 cases of leukaemia a year from x-radiation *in utero* must be set against 439 deaths of mothers in childbirth, 15,829 stillbirths and 9,750 deaths in the first week of life in 1955. Obstetricians and radiologists believe that the mortality of mother and child may be significantly reduced by appropriate x-ray examinations in pregnancy and that they can save more lives than are likely to be lost from leukaemia, appreciating as they do now the hazards of x-radiation. Similarly, the death rate from leukaemia after radiotherapy for ankylosing spondylitis is only 3 per 1,000 and . . . is a good deal lower than the mortality of 13 per 1,000 for interval partial gastrectomy for peptic ulcer in the best hands."

In seeking to define the dose-effect relationship for radiation carcinogenesis, experimental studies clearly point to a threshold relationship for regional irradiation. The author's studies have indicated that local irradiation of the skin of rats with a large single dose of soft x-rays of 4,000 r produces a high yield of epitheliomas and soft-tissue sarcomas, in or about the irradiated volume, halving of the dose (2,000 r) is attended with the zero incidence common to unirradiated animals of similar strain.

It is concluded that there is a clear distinction be-

tween the ionizing radiation and carcinogenic available diagnostic incidence ing to the hypothesis The gen ferent app the hazard clear, and such as calculation terms, ar fertile life the spon genetic e know wh taneous the ethic inite imm remote g

### Radiation

M. J. Australia

In inc graphic other m scopie e purposes ponents in self-l for the industri gamma eral adv measure rolling, following in water many agricult The l

ing rad lesions loss of f nails, lo and, m formati possibl tion; (sarcor active forming disease cer of rad effects sterilit the gon ous gen popul Some shorte The



tween the genetic hazard incurred by the medical use of ionizing radiations and the hazard of leukemogenesis and carcinogenesis. There is no acceptable evidence available that regional radiation procedures, either diagnostic or therapeutic, proportionately increase the incidence of leukemogenesis and carcinogenesis according to the magnitude of the dose received locally, on the hypothesis of a "non-threshold" effect.

The genetic hazard, on the other hand, requires a different approach by the radiologist. Here, the nature of the hazard and its effect on future generations is not clear, and we cannot think in terms of an absolute value such as mortality. We are forced to accept indirect calculations and extrapolations, which, put in practical terms, arrive at a cumulative dose value for a specific fertile life span and are based on a predicted doubling of the spontaneous mutation rate and its effect on the genetic equilibrium of the race of the future. We do not know what would be the effect of doubling the spontaneous mutation rate in man, and are even less sure of the ethical values involved in the choice between a definite immediate gain to the individual and an indefinite remote genetic upset.

ALFRED O. MILLER, M.D.  
Louisville, Ky.

**Radiation Hazards in Industry.** Gordon C. Smith. *M. J. Australia* 2: 313-315, Sept. 6, 1958. (University of Sydney, Sydney, Australia)

In industry, x-ray equipment is used for the radiographic examinations of castings, forgings, welds, and other metal structures, for defects, and for the fluoroscopic examination of manufactured articles for such purposes as checking for the correct assembly of components or detecting foreign material. Radium is used in self-luminous paints, for gamma radiography, and for the elimination of static electricity. Important industrial uses for radioisotopes are as sources for gamma radiography, for which purpose they have several advantages over x-ray equipment, as gauges to measure and control the thickness of materials during rolling, and for many other purposes, as package sorting, following the flow of oils in pipelines, detecting leakage in water lines, oil lines, or gas mains, and as tracers in many chemical, physical, engineering, metallurgical, agricultural, and biological processes.

The known effects of occupational exposure to ionizing radiations are summarized as follows: (1) skin lesions such as erythema, burns, dryness, and cracking, loss of hair, chronic dermatitis, ulceration, distortion of nails, loss of fingerprint patterns, hyperkeratosis, warts, and, most important, malignant changes; (2) cataract formation, especially from neutron irradiation and also possibly from larger doses of beta, gamma, and x-radiation; (3) degeneration, necrosis, and malignant disease (sarcoma) of bones as a result of deposition of radioactive substances; (4) damage to the blood and blood-forming tissues, which may lead to severe and fatal disease such as aplastic anemia and leukemia; (5) cancer of the lung from inhalation of the radioactive gas, radon, and other daughter products of radium. Other effects of radiation include temporary or permanent sterility or impaired fertility as a result of damage to the gonads, and there is the very important risk of serious genetic effects if a sufficiently large proportion of the population becomes exposed to excessive radiation. Some evidence also exists that irradiation may cause shortening of the normal life span.

The hazards associated with uranium mining and

processing appear to be debatable. According to Hodge (*Arch. Indust. Health* 14: 43, 1956), uranium is one of the most toxic elements chemically. Provisionally it is absorbed into the body only with difficulty. Deposition in bone is no radiological hazard, for toxic effects on the kidney would be fatal long before enough uranium was absorbed into the body to give a radiologically hazardous concentration in the skeleton. Eisenbud and Quigley (*Arch. Indust. Health* 14: 12, 1956), on the other hand, conclude, on the basis of experience with severe exposures to both soluble and insoluble compounds, that uranium has a low order of chemical toxicity in man.

Legislative control measures in Australia are outlined.  
ALFRED O. MILLER, M.D.  
Louisville, Ky.

**The Estimation of the Nonrecuperable Injury Caused by Ionizing Radiation.** John S. Krebs, Ralph W. Brauer, and Harvey Kalbach. *Radiation Res.* 10: 80-88, January 1959. (U. S. Naval Radiological Defense Laboratory, San Francisco, Calif.)

Evidence has been accumulating in the recent literature to show that exposure of animals to doses of ionizing radiation which fail to cause acute death results in a variety of late pathological lesions leading in most cases to reduced life expectancy (*Radiology* 63: 562, 1954). Although it must be supposed that exposure to radiation results in a latent injury from which the animals do not recover, the presence of the injury is usually masked by an extended period of apparent normalcy prior to the development of the late lesions and foreshortened survival. In a previous communication (*Progress in Radiology*, pp. 396-400, Oliver & Boyd, London, 1954), the authors pointed out a method which could be used to unmask this injury. If the word "injury" is allowed to take on the somewhat restricted meaning of "susceptibility to acute death," then the amount of such injury in an animal caused by a sublethal dose of ionizing radiation can be measured at any time after exposure to the radiation in terms of the amount of additional radiation necessary to cause acute death.

In the application of the technique to the present study, the animals were irradiated in a fractionated-dose scheme so that a large dose could be given without significant loss of animals by acute death, and a sufficient time after completion of the irradiation was allowed before testing for injury so that this would have decreased to a level where further recovery was not demonstrable. Under such conditions the injury found represents nonrecuperable injury caused by ionizing radiation.

All animals employed in these studies were C3H female mice. The irradiation was begun when the animals were approximately nine weeks old. The conditioning irradiation was administered in two or more doses of 300 r each, separated by intervals of three weeks. After completion of the course of conditioning exposures, the mice were held from four to twenty weeks and were then tested for injury by exposure to additional radiation to determine the dose-response curve.

The exposure of the mice to the nonlethal course of irradiation resulted in a reduction in their tolerance to further x-ray treatment. The reduction in tolerance to x-rays, measured as a lowering of the LD 50, was linearly proportional to the dose to which the animals were previously exposed, and thus can serve as a measure of permanent injury induced by the x-rays. The evidence



obtained does not indicate that the x-ray exposure changes either the mechanism of acute irradiation death or the distribution of sensitivity to x-rays. The injury found does not account for the observed mortality of animals from chronically imposed radiation.

Two graphs; 3 tables.

**Radiation Exposure of Patient and Personnel During Urographic Procedures.** H. S. Weens, R. H. Rohrer, and H. D. Youmans, Jr. *J. Urol.* **81**: 232-238, January 1959. (Emory University School of Medicine, Atlanta, Ga.)

Since from 10 to 20 per cent of all diagnostic radiation exposure to ovaries and testes stems from urographic examinations, it behooves both the roentgenologist and urologist to employ every protective measure available. The potentially harmful somatic and genetic effects of radiation must be weighed, however, against the benefits which diagnostic radiation has brought about in modern medicine.

Fortunately, rather simple procedures, if rigidly administered, will significantly reduce radiation exposure to patient and personnel. Such methods include:

1. Elimination of unsatisfactory examinations due to faulty position, motion, and improper exposure.
2. Field limitation by use of proper rectangular cones, and examination only of areas of clinical interest.
3. Shielding of testicles so that testicular radiation exposure is largely limited to that from the patient's body.
4. Filtration of x-ray beam to eliminate soft rays which contribute little to image formation.
5. Improvement of film-developing techniques.
6. Film and screen selection; use of high-speed equipment.

By combination of these measures, the radiation exposure may be reduced to about one-third without sacrificing essential examinations.

Three roentgenograms; 2 diagrams; 2 tables.

ROBERT E. CAMPBELL, M.D.  
University of Pennsylvania

**Radiation Outside the Defined Field.** J. H. Martin and Ann Evans. *Brit. J. Radiol.* **32**: 7-12, January 1959. (Peter MacCallum Clinic, Melbourne, Australia)

An investigation of the genetic dose due to therapeutic procedures involving the use of radiation is considered under three headings:

1. Dose to the gonads of a patient when these are outside the field of radiation. Graphs are presented which show the variation of scatter with distance from beam edge, with depth below the surface, and with quality of radiation. A range of field sizes from  $4 \times 4$  to  $19 \times 19$  is covered, and of quality from h.v.l. 0.07 to 15.5 mm. Cu.
2. Dose to the patient, or to an individual holding the patient, from leakage through the tube housing. Measurements were made at 50 cm. from the focal spot in a plane containing the axis of the tube and of the x-ray beam, and in a plane at right angles to this and containing the axis of the beam; h.v.l.'s were also measured. The authors conclude that the gonads of children or young adults should be screened during treatment.
3. Dose to an individual holding the patient from radiation scattered from the patient. Graphs show the

increase in scatter with the two dimensions of the field. It was found that in general scatter from the patient is of greater importance than leakage through the tube housing, and that a lead apron should be worn.

Two figures; 19 graphs.  
LUCILLE DU SAULT  
The Henry Ford Hospital

**Practical Radiation Protection.** Adrian Johnson. *M. J. Australia* **1**: 38-42, Jan. 10, 1959. (Sydney, Australia)

The author attempted to determine how much the dose to the gonads could be reduced in roentgen diagnostic studies and therapeutic irradiation. A Philips pocket dosimeter was laid on a table consisting of horse-hair covered with leather. When the underside of the table was covered with 3-pound lead to shut off scattered radiation from the floor, the gonad dose fell by 55 per cent. If the x-ray tube head and filter tray opening were enclosed with 3-pound lead, the dose was also significantly reduced. A reduction of the dose to the gonadal area of 33 per cent was obtained by limiting the field with a cone and a like reduction was effected by placing the tube so that it did not point in the general direction of the gonads. Tilting the tube away from the gonad area brought about a reduction of 84 per cent, and lowering the kilovoltage, with consequent lower quality of radiation, a reduction of 45 per cent. A low "skin dose" achieved by filtration and a high kilovoltage may mean a higher gonad dose. In the treatment of a patient with severe acne, the gonad dose was reduced from 135 mr to the point where none was recorded, by the wearing of a lead rubber apron. A sheet of 3-pound lead placed over the lower part of the trunk in addition to a lead rubber apron has been found more efficient than two thicknesses of lead rubber.

A dosimeter would appear to be a great help to all those operating x-ray equipment, not only in assessing the gonadal dose to which patients are exposed, but also for the protection of the operators. A random survey showed that by easily corrected faults of technique, such as failure to adapt the eyes before fluoroscopy, outputs higher than necessary are used in practice.

Six photographs; 9 tables.

**Tolerance of Skin Grafts to Radiation: A Study of Postmastectomy Irradiated Grafts.** R. W. Cram, C. H. Weder, and T. A. Watson. *Ann. Surg.* **149**: 65-67, January 1959. (University of Saskatchewan, Saskatoon, Sask., Canada)

Fifteen cases of radical mastectomy in which skin grafting was done were treated with postoperative irradiation ( $\text{Co}^{60}$  telecurie therapy at 80 cm. distance for a skin dose of between 4,200 and 4,900 r, or 280 kv, h.v.l. 2.5 mm. Cu, 50 cm. distance, skin dose 4,200 r), the grafted areas being partly or wholly in the treatment fields. In all cases the grafts survived and reacted the same as the surrounding skin, without complications.

The authors conclude that tolerance of skin grafts to irradiation is approximately the same as of normal skin.

Four color photographs.  
ZAC F. ENDRESS, M.D.  
Pontiac, Mich.

**The Effect of Internal Emitters on Red Cell Survival in Beagle Dogs.** John E. Parkinson. *Radiation Res.* **10**: 63-66, January 1959. (Department of Anatomy, University of Utah, Salt Lake City, Utah)

An investigation was made of the effect of internal emitters on red cell survival in adult beagle dogs in-

jected intravenously with graded doses of isotopes and examined at different dose levels and times of exposure. Isotope burdens on a retained basis were as follows: for mesothorium and radiothorium, 0.27, 0.81, and 2.5  $\mu\text{C}/\text{kg}$ . The figures for radium and plutonium were 0.81 and 2.5  $\mu\text{C}/\text{kg}$ . Anemia occurred at one to six months postinjection, with recoveries and relapses at later times. Red-cell survival was determined by a method employing radiochromium.

Red-cell  $\text{Cr}^{51}$  uptake ranged from 72 to 91 per cent. Red-cell volume in 25 controls ranged from 35.4 to 69.9 ml./kg. (average = 42.7 ml./kg.). Isotope-injected animals with red-cell volumes below 35.4 ml./kg. were considered anemic (range = 22.7 to 35.2 ml./kg.; average = 28.7 ml./kg.).

In general, the frequency distribution of 50 per cent red-cell survivals for isotope-injected animals was the same as in controls, though there were more anemic dogs at the low range of normal. There was no evidence in these animals of hemorrhagic tendency or external blood loss.

Survival of red cells was followed for ninety-one days. The calculated life span was one hundred and fifty-eight days with a variance of errors for the fit of 0.143 per cent  $\pm 0.98$ .

The time for reduction in survival of red cells to 50 per cent in normal beagles in this study (twenty to thirty-two days) compares closely with that of normal mongrel dogs (twenty-one to thirty days) obtained by other workers. There was no definite hemolytic component as indicated by  $\text{Cr}^{51}$ -labeled red-cell studies in the anemia secondary to internal irradiation in beagles. Slight damage to red cells is suggested, however, by the fact that survival for many of the anemic irradiated dogs fell into the low normal range.

**Effects of Heavy Particle Irradiation on Acute Mortality and Survival Time in the Mouse.** V. P. Bond and O. D. Easterday. *Radiation Res.* 10: 20-29, January 1959. (Brookhaven National Laboratory, Upton, N. Y.)

In an earlier article (*Radiology* 67: 650, 1956), the procedure for acute total-body irradiation of the mouse with heavy particles by thermal neutron exposure of animals injected previously with isotopes such as  $\text{B}^{10}$  or  $\text{Li}^7$  was presented in detail, and the effects of heavy particles from boron capture as determined from spleen-thymus weight loss end-points in mice were described. The authors now report the effects of  $\text{B}^{10}$  and  $\text{Li}^7$  capture radiations on acute mortality and survival time in the mouse.

The twenty-eight-day mortality rate was determined for female CFI mice given  $\text{B}^{10}$ -enriched borax or  $\text{Li}^6$ -enriched  $\text{LiCl}$  intravenously and exposed five minutes later to graded doses of total-body thermal neutron radiation. The LD 50 values were as follows: 25  $\mu\text{g}$ . of  $\text{B}^{10}$  per gram,  $1.30 \pm 0.11 \times 10^{13}\text{n}/\text{cm}^2$ ; 33.3  $\mu\text{g}$ . of  $\text{Li}^6$  per gram,  $0.84 \pm 0.04 \times 10^{13}\text{n}/\text{cm}^2$ ; thermal neutrons alone,  $4.77 \pm 0.14 \times 10^{12}\text{n}/\text{cm}^2$ ; cobalt-60  $\gamma$ -radiation,  $789 \pm 30$  r. The RBE for the heavy particles ( $\alpha$  and  $\text{Li}^7$ ) from  $\text{B}^{10}$  neutron capture was calculated to be 2.0; a value of 3.2 was obtained for the particles ( $\alpha$  and tritium) from  $\text{Li}^6$  neutron capture. The tendency to three- and four-day deaths was found to be much more pronounced in animals exposed to heavy particle irradiation than in those exposed to x-ray,  $\gamma$ , fast neutron, or thermal neutron irradiation.

**Treatment of Mouse Lymphosarcoma by Total-Body X Irradiation and by Injection of Bone Marrow and Lymph-Node Cells.** M. J. de Vries and O. Vos. *J. Nat. Cancer Inst.* 21: 1117-1129, December 1958. (Radiobiological Institute of the National Health Research Council TNO, Rijswijk Z. H., Netherlands)

The authors have studied the effect of a supralethal dose of total-body x-irradiation on the growth of a transplantable mouse lymphosarcoma. In this paper they present the results of experiments in which mice inoculated with this tumor were treated after irradiation by injection of isologous, homologous, or heterologous (rat) bone marrow and lymph-node cells.

The mice treated with isologous bone marrow died of lymphosarcoma at about the same time as the unirradiated, untreated control mice, showing that the tumor could not be eliminated by a supralethal dose of total-body x-irradiation.

There was prolonged survival and definite inhibition of the lymphosarcoma in the mice treated with homologous or heterologous bone marrow and lymph-node suspensions. It is presumed that the homologous and heterologous lymphoid cells inhibited growth of the lymphosarcoma by reacting immunologically against antigenic material of the mouse. These animals eventually died, however, either of lymphosarcoma or foreign bone-marrow reaction.

The longest survivals were achieved in the mice treated with isologous bone marrow and large quantities of isologous lymphoid cells shortly after irradiation. It seems probable that the inhibition of lymphosarcoma growth in this case is a consequence of competitive proliferation of normal and irradiated neoplastic lymphoid cells in the irradiated host.

Five diagrams; 1 table.

JAMES A. BURWELL, M.D.  
Mercy Hospital, Pittsburgh, Penna.

**The Early Gastrointestinal Response in the Rat Exposed to Whole-Body X-Irradiation.** D. G. Baker and C. G. Hunter. *Radiation Res.* 9: 660-666, December 1958. (C. H. Best Institute, University of Toronto, Toronto, Ont., Canada)

The work reported by the authors was undertaken to obtain more detailed information concerning the time course of gastrointestinal disturbances after radiation injury and to determine whether the rat showed an early response comparable to that of primates.

Fasting rats were exposed to whole-body x-irradiation in doses of 100, 300, 500, and 700 r. Immediately prior to fasting, powdered charcoal was incorporated into the diet in order to mark the progress of the food along the intestinal tract. During the first five hours postirradiation, the weight of the stomach contents in all groups increased. At the same time the movement of the carbon particles indicated that there was an antiperistalsis in the small intestine that caused the intestinal contents to be regurgitated into the stomach.

The initial reaction of the general radiation syndrome in primates is of sudden onset and, depending on dose, dose rate, and other factors, is associated with nausea and vomiting. The rat, in the course of its evolution, has discarded the vomiting reflex, probably owing to its having a greater sense of discrimination in regard to food and a gut less sensitive to bacteria and their toxins than do dogs, cats, and primates. When subjected to radiation injury, it is at a disadvantage. Although

small gut regurgitation follows radiation injury, vomiting is impossible, and the contents of the stomach must wait until they are evacuated through the small intestine. This will not occur until the small gut has had an adequate time for the recovery of the local injury.

Three figures; 1 table.

**Role of Food Consumption in the Mortality Response of Irradiated Rats Subjected to Prolonged Cold Exposure.** Bernard D. Newsom and Donald J. Kimeldorf. *Am. J. Physiol.* 195: 271-275, November 1958. (U. S. Naval Radiological Defense Laboratory, San Francisco, Calif.)

Prolonged exposure to a low ambient temperature was found to increase the thirty-day mortality rate of irradiated rats. To determine if the increased mortality was due to a failure to adapt to the higher metabolic demands of a cold environment, the food consumption of irradiated (500 r, 600 r, 250-kv x-rays) animals was measured during thirty days of exposure at normal (23° C.) or lowered (6° C.) environmental temperature.

The food consumption of irradiated animals was increased by exposure to cold; this increase, however, was not sufficient to maintain body weight at a level comparable to that of nonirradiated animals. When the food consumption of nonirradiated animals was limited to that of irradiated animals during exposure to a 6° C. environment, the mortality observed among nonirradiated animals was comparable to the increase in mortality induced by cold exposure of irradiated animals. These results suggest that the increased mortality rate of irradiated animals in a cold environment is related to an inadequate food intake.

Three figures; 2 tables.

**The Role of Bile Secretion in the Gastrointestinal Radiation Syndrome.** Kenneth L. Jackson and Cecil Entenman. *Radiation Res.* 10: 67-79, January 1959. (U. S. Naval Radiological Defense Laboratory, San Francisco, Calif.)

The authors report an investigation of the role of bile secretion in the gastrointestinal radiation syndrome of the 1,500-r x-irradiated rat. Ligation of the bile duct was found to increase the mean survival time of irradiated rats as much as 70 per cent, and to reduce the excretory loss of sodium. When changes in the sodium content of the gastrointestinal tract were taken into consideration, the estimated body sodium loss was almost as great as the measured sodium secreted in bile by irradiated rats during the same period. It is concluded that in the irradiated rat (1) the loss of body sodium due to net leakage of this electrolyte directly across the intestinal wall is of minor importance; (2) the major portion of the body sodium loss is the result of an inadequate absorption of bile sodium, which is secreted into the intestine at a normal rate; (3) the loss of sodium via the bile is an important factor in the cause of death.

Six figures; 3 tables.

**The Influence of Cortisone on the Teratogenic Activity of X Radiation.** D. H. M. Woollam, J. W. Millen, and J. A. F. Fozzard. *Brit. J. Radiol.* 32: 47-48, January 1959. (Department of Anatomy, University of Cambridge, Cambridge, England)

Prompted by the investigations of others, the authors undertook to ascertain whether cortisone affected the

incidence of malformations in the young of female rats exposed to irradiation during pregnancy. Three groups of 12 pregnant rats each were employed in the experiment. Animals in Groups 1 and 2 received 258 r of x-radiation on Day 11 of pregnancy. Animals in Groups 2 and 3 were given 20 mg. of cortisone acetate on Days 9 to 12 of pregnancy. The rats were killed on Day 20 of pregnancy.

The young of dams in Group 3 exhibited no deformities; 5.2 per cent of the young from Group 1 and 18.8 per cent of the young from Group 2 showed malformations of the eye ranging from coloboma to anophthalmia. These findings indicate that cortisone exerts a potentiating effect on the teratogenic action of x-radiation.

Six figures; 1 table.

**Biological Effect of the Cellular Structures in Normal and Irradiated Rabbits.** N. N. Klemparskaya, R. V. Petrov, and L. I. Ilyina. *Med. radiol., Moscow* 3: 34-40, January-February 1958. (In Russian)

When fractions of cellular microstructures of the liver and intestinal mucosa of normal and irradiated rabbits were injected into animals of the same species, there resulted active immediate and remote effects. The immediate effect was death from shock in the presence of leukopenia, especially if there had been internal introduction of mitochondria of the intestinal mucosa. The preparation proved five to seven times more active in irradiated animals than in the control series. The remote biological effects manifested themselves in general changes in the health of the recipient animal: loss of weight, fever, leukocytosis, and death with necrosis of the intestinal mucosa and pulmonary hemorrhage. There were also modifications of the reactivity of the recipient to experimental microbial infection and of the response to ionizing radiation.

ERNST A. SCHMIDT, M.D.  
Gardena, Calif.

**The Effect of Dose Rate on Genetic Damage from Fast Electrons in *Drosophila* Sperm.** Armon F. Yanders. *Radiation Res.* 10: 30-36, January 1959. (U. S. Naval Radiological Defense Laboratory, San Francisco, Calif.)

Mature sperm of male *Drosophila melanogaster* were exposed to 3,200 rads of fast (1.6-Mev) electrons from a Van de Graaff accelerator, at rates ranging from 210 rads/min. to 6,400 rads/min. The amount of genetic damage was assessed by measurements of the frequency of induction of sex-linked recessive lethal mutations and dominant minute effects.

No significant differences attributable to radiation dose rate were found between treated groups. The dose-rate effects reported by others using x-rays were not observed with fast electrons. Two possible reasons for the disagreement are offered: (1) There is a great difference in the linear energy transfer (LET) between the average electron from 250-kvp x-rays and 1.6-Mev electrons, the former having an LET about ten times as great as the latter. This difference in LET might be responsible for the existence of a rate effect with x-rays and not with electrons. (2) There may be an optimum rate of dose at which the greatest amount of damage is produced. If this is true, rates substantially higher or lower than the optimum would not exhibit pronounced differences in effectiveness.

ber 1959

le rats  
groups  
experi-  
r of 1-  
Groups  
Days  
Day 20

formi-  
d 18.8  
orma-  
hthal-  
erts a  
radia-

ormal  
R. V.  
: 34-

liver  
bbits  
there  
The  
sence  
al in-  
cosa.  
ctive  
The  
gen-  
loss  
crosis  
nage.  
f the

D.  
if.

from  
and-  
U. S.  
isco,

were  
om a  
210  
netic  
ency  
ions

tion  
The  
were  
sons  
reat  
veen  
Mev  
es as  
be  
rays  
num  
ge is  
r or  
ced